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ECONOMIC GEOGRAPHY

JULY

THE RURAL-URBAN FRINGE
George S. Wehrwein

AGRICULTURAL REGIONS OF AFRICA
H. L. Shantz

COAL AND POLITICAL POWER IN EUROPE
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MICHIGAN LIMESTONE INDUSTRY
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Ronald L. Ives

SKI GEOGRAPHY OF NEW ENGLAND
Albert S. Carlson

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ECONOMIC GEOGRAPHY

CONTENTS FOR JULY, 1942

THE RURAL-URBAN FRINGE 217
GEORGE S. WEHRWEIN

AGRICULTURAL REGIONS OF AFRICA. PART III.—PRESENT AND POTENTIAL PRODUCTIVITY OF THE LAND 229
H. L. SHANTZ

COAL AND POLITICAL POWER IN EUROPE 247
WALTER H. VOSKUIL

MICHIGAN LIMESTONE INDUSTRY 259
PAUL CROSS MORRISON

CUYUNA IRON RANGE 275
GEORGE F. BRIGHTMAN

POTATO FED SWINE IN GERMANY 287
EARL SHAW

POPULATION CHANGES IN A MOUNTAIN COUNTY 298
RONALD L. IVES

SKI GEOGRAPHY OF NEW ENGLAND 307
ALBERT S. CARLSON

BOOK REVIEWS 321

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THE PACIFIC NORTHWEST

OUR Pacific Northwest represents the most youthful and most promising region and people of our country. Only recently reclaimed from the wilderness, only recently populated and developed, only recently a vital part of our country and the world's economy as the records of the centuries run, it has made for itself a place in the world's affairs that none other can preëmpt. It plays an important role in the destinies of our country, in the mobilization of our strength and our resources for national defense and final triumph for the ideals of Democracy.

Our Pacific Northwest is democracy regionalized. It forms a cross section of the ancestries, the languages, the systems of land use, the ideals of government of our whole country. Its diversities of origin of population, its distinctive and intense faith in equality and liberty and justice, its impatience of sham and form and convention stamp it with youth and virility, with ability and eagerness to achieve. It is a region of young folk, of young industry, of young burning ambition, and fateful promise of power. If we are proud of our Pacific Northwest it is because we all recognize in it our whole country epitomized in all its history, and opportunities, and frontier enthusiasm.

The Pacific Northwest in this war is one of our elements of economic and political strength, just as it constitutes one of our strategic weaknesses and hazards. Should we lose naval supremacy in the Pacific, our Northwest might become the Achilles heel of our resistance to invasion. Loyal and patriotic to the last man and woman, the folk of the region would fight to the death against any and all aggression, but they are all too few and their position too vulnerable for our complacency.

ECONOMIC GEOGRAPHY

VOL. 18 JULY, 1942 No. 3

THE RURAL-URBAN FRINGE

George S. Wehrwein

LAND problems appear in their most acute form on three fringes or transition zones: (1) the area between arable farming and grazing; (2) the zone between farms and forests; and (3) the suburban area lying between the built-up city and farms. In recent years much attention has been given to the two former "fringes"; the "Dust Bowl" and the "cut-over" areas are familiar figures in land utilization literature. Much less has been done by research agencies and administrators in the other twilight zone—the rural-urban fringe. Students of agricultural land problems stop when they come to "city land" and urban land economists and planners usually stay within the city limits, unless they are studying the region and making regional plans. Meanwhile residences are spreading into the fringe, industries are "decentralizing," and commercial establishments in the form of traffic-attracted industries are locating themselves along major highways, reaching many miles beyond the residential or the industrial invasion. Urban problems, crying for direction, planning, and social controls, are thrust upon rural governments, yet these units of government are not designed for or are incapable of furnishing direction, plans, or controls. Unguided "settlement," premature subdivisions, unwise expansion of public utilities with increased expenditures for local government have resulted in tax delinquency and suburban slums. Pathological conditions of this kind focused attention on this transition zone just as they did to the cut-over regions and the High Plains.

It is the purpose of this article to examine the land use structure of the rural-urban fringe which may be defined as the area of transition between well recognized urban land uses and the area devoted to agriculture. That this is not a hard and fast, well defined area is evident from this description. The "built-up" city is not necessarily coterminous with the political city. In many cases the economic and sociological city, the area within which people live the urban way of life, has extended far beyond the city limits; in other cases farms on which people live the rural way of life are found within the political boundaries of cities. The 1940 census reported almost 260,000 *urban*-farm population. Likewise the city and the rural-urban fringe may or may not cover the same area as the metropolitan district as defined by the United States Census. The fringe area is much smaller than the trade area and usually smaller

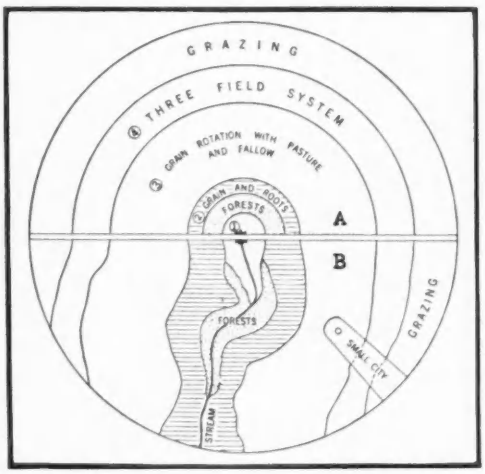

FIGURE 1.—Land utilization as determined by location. Modified from diagrams in von Thünen's *Isolated State*. (From Ely-Wehrwein, *Land Economics*, Macmillan, 1940.)

than the commuting area of a given city. It can best be identified in terms of land uses or modifications of land uses than in any other way.

VON THÜNEN'S SCHEME OF LAND UTILIZATION

In reviewing the literature which throws light on the land utilization of the fringe the student will find von Thünen's "Isolated State" a good beginning. Von Thünen eliminated all natural features, climate, soil, topography or anything else which might affect the utilization of land except the presence of a single city in the center of a uniform plain with an agricultural economy. Given only wagon transportation, with no well defined highways, the cost of bringing farm products to the city is equal for all points equally distant from the market. The result is a system of concentric belts or zones about the central city (Figure 1).

In the first zone only high priced, perishable, and bulky products can profitably be grown and marketed, such as milk, eggs, berries, and vegetables. Under the conditions of 1826 (when the first edition of von Thünen's book was published) the presence of a belt of forests as the second zone was not so incongruous as it might seem. Practically all building material, fuel, and other bulky forest products had to be brought to the city by wagons or even on the backs of the peasants. Agricultural zones reappeared beyond the forest belt; gradually farming became less and less intensive until grazing merges into the wilderness which surrounds the "state" and shuts it off from the rest of the world.

In this oversimplified scheme of land utilization there is no rural-urban fringe as we know it today. The city boundary sets the limit of the "urban way of life"—beyond it are farms and agricultural land uses. Nevertheless, the intensive use of land, small farms, high priced land, dense population, and almost daily contact with the city in marketing their crops means a way of life for the farmers intermediate between that of the city dweller and the general farmer or forester. It is the kind of life and type of agriculture that are often pictured as still existing on the outskirts of our cities but which have been metamorphosed beyond recognition by the forces which have produced the "fringe problems." It is the kind of land utilization, way of life, and occupations hoped for in the "greenbelts" around the "Greenbelt Towns," a girdle of permanent open space intended "to protect the town forever from overcrowding and undesirable building on neighboring land." This belt was designed to contain not only parks, playgrounds and the gardens of the urban inhabitants, but also full-time farmers "who can bring their produce to market by crossing their own fields." (*Greenbelt Towns: A Demonstration in Suburban Planning*, published by the Resettlement Administration, Washington, D. C.,

September, 1936. The distribution of the land uses in a typical community was planned as follows: community and store buildings, 100 acres; homes, 1000 acres; parks, 1800 acres; farms, 2100 acres.)

Park and Burgess in their study of city structure conceived of a similar system of concentric zones within the city itself, beginning with the commercial and industrial core and ending with the dwellings of the wealthier "classes" at the periphery of the city. Coupled with von Thünen's scheme for the area beyond the city, the two together form an idealized scheme of land utilization which, however, has so many exceptions that it is sometimes difficult to prove the rule! This orderly arrangement rules out the influence of natural factors which are often predominant. It also presupposes a static population, which, indeed, was the basic assumption of some of the Garden Cities. It is only with a static population that the greenbelt of parks, playgrounds, gardens, and farms can be maintained against the invasion of a growing city or, if the city is permitted to expand, plans must be made for the gradual expanding core, the expansion of the residential area and the shifting of the rural land uses to urban land uses.

However, few cities have been static; all of them expect to grow, and, with this expectation in mind, they make their plans accordingly whenever they plan at all. Growth does not take place equally on the periphery of the city and probably never has in spite of the concentric circles of the Isolated State. Transportation has always followed definite routes; even the camel, pack horse, and ox cart followed certain paths and entered the ancient and medieval city at city gates. The "Isolated State" itself must have a system of "farm to market" roads which gives the farms adjacent to such roads a locational advantage over those not so situated. Fruit, vegetable, dairy, and poultry farms could be located farther away from the city if situated on a direct road to the city than if not so placed. Von Thünen recognized this when he introduced the river in his diagram and the circles became distorted by projections following the stream (Figure 1B).

CHRISTALLER'S SCHEME OF URBANIZATION

The von Thünen scheme of a single city in a large uniform hinterland of an agricultural economy is of course highly theoretical and is useful primarily for isolating of the economic from the natural and other factors determining land utilization. More realistic is the scheme of Walter Christaller. (Walter Christaller, *Die Zentralen Orte in Süddeutschland*, Jena, Gustav Fischer, 1933.)

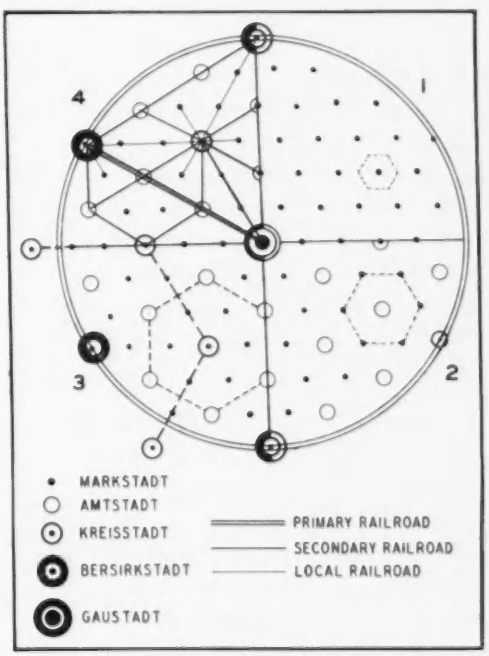

FIGURE 2.—Theoretical distribution of trade centers. (Based on diagrams made by James A. Barnes, after W. Christaller.)

Assuming once more a uniform agricultural economy it is evident that not all non-rural functions will be centralized in one city. The farmer needs the services of the blacksmith and other craftsmen, the store, the church, school, and a tavern, dance hall or other recreational centers depending on the customs and mores of the people. Christaller suggests that these services would grow up at certain centers and form hamlets evenly distributed over an area assumed to be as uniform as that of the "Isolated State." Each hamlet tends to serve an area hexagonal in shape as shown in Sector 1 of Figure 2. However, the hamlet cannot furnish all the services the farmer wants, so some of the villages become the center for doctors, lawyers, hospitals, let us say, serving the rural people in a larger area and those living in the neighboring hamlets as well. This larger area is shown in Sector 2 of the same Figure. In this way Christaller builds up a hierarchy of urban centers of which the most important is the "central" city of von Thünen's Isolated State (Sector 3).

The even distribution of cities of various characteristics, sizes, and "hinterland areas" is disturbed by natural factors, locational advantages for manufacturing and "through lines" of transportation. Iowa, because of its agricultural economy might have come close to furnishing an example of Christaller's principle. However, the Missouri and Mississippi rivers on its borders, the three important rivers within the state, and the transcontinental railways located and later influenced the growth of the cities of Iowa so much that their distribution is far from uniform over the state.

Christaller's contribution has significance for the rural-urban fringe in that every one of these urban concentrations will become the basis for a series of belts and zones just as the central city does and the larger cities will tend to develop "fringe areas." This was recognized by von Thünen when he introduced another city in his diagram (Figure 1). More important still is the fact that the distribution of urban centers will determine the transportation system. According to Christaller each hamlet is connected with the rural area it serves and in turn it is linked with the village or city next in rank, resulting in a system of primary, secondary, and local roads and railways. This is indicated in Sector 4 of Figure 2. Thus a hierarchy of highways is unfolded bearing a volume of traffic in proportion to the size of the cities connected. Moreover, the large urban centers are linked, not only with the cities of a system such as this, but with other metropolitan centers and their "systems." Thus transportation becomes channelized and certain railways, roads, waterways, and air lanes become the main arteries for quick, uninterrupted traffic for passengers and goods. Such railways are double tracked and roads are made into two, three, or four lane highways to carry the heavy traffic; in fact, some of these main highways are merely a connection of "Main Street" of one city with the "Michigan Avenue" or "Broadway" of another.

RAILWAYS AS "DECENTRALIZING" FACTORS

Not only the agricultural zones but the city itself tends to follow the lines of transportation. However, as long as animal power was the usual means of transportation the city dweller who had business or sought pleasure in the "downtown" part of the city was constrained to live as "close in" as possible. (In 1866 New York had a well organized system of coach, omnibus, and horse railway transportation yet

their range was so limited that the outlying districts were undeveloped while the central streets were badly congested. "The most desirable parts of the island, the sections abreast of and above Central Park, were largely given up to pigs, ducks, shanty squatters, and filth, while lower Broadway was so jammed that a man in a hurry almost lost his reason." Allan Nevins, *The Emergence of Modern America, 1865–1878*. Macmillan. 1927. pp. 81–82.) This tended to keep the city structure compact, and the competition for accessible sites raised rents and site values. "The expenses of living in the city are increasing every year. Rents are higher now than ever before and there is no prospect of their coming down for many years," has a distinctly modern tone but was said of New York in 1865 by George E. and F. W. Woodward. (*Woodward's Country Homes* by George E. and F. W. Woodward, New York, 1865, 5th edition, p. 12.) Railways were among the first decentralizers and levelers of urban rents and value. "The remedy for this," continue these writers, "is to go into the country. Along the lines of our railroads and navigable waters there are localities where land is abundantly cheap—beautiful healthy regions, where the comforts of a rural home may be secured. . . . We know of localities which can be reached from Wall Street in as many minutes as would be required to go to 50th Street. . . . In the direction we have now specially in mind, there are at least 20 railroad trains which stop at convenient stations between early morning and ten o'clock at night."

The fact that railway trains stop only at definitely located stations no matter how "convenient" tended to produce settlements or agglomerations of population strung along the railway lines rather than a continuous band of residences projecting from the city. The early street cars rarely went outside of the city's limits but when these were transformed into interurban electric lines, projected into the rural areas or connected with near-by cities, the boundaries of the city were stretched still more. Interurbans could be "flagged" at any crossroad, which tended to eliminate the islands of residential areas and make the areas linear in structure. This once popular form of transportation is now almost forgotten, but Figure 3 shows that Indianapolis had almost as many electric interurban railways as steam railways in 1914. The map also shows the characteristic pattern of lines of transportation radiating from a "central" city cutting the rural-urban fringe into wedge-shaped tracts between the lines.

HIGHWAYS AND THE "METROPOLITAN INVASION"

However, the real exodus of residences and of commercial establishments generated by traffic did not come until the automobile and hard-surfaced roads provided means of swift, unchanneled, individual transportation as compared with the previous channeled mass transportation. The rural-urban fringe then became penetrated by streaks of urban land uses also radiating from the center like the spokes of a wheel. The primary roads, carrying the heaviest traffic, were most affected. This Benton MacKaye termed the "metropolitan invasion" (in his book, *The New Exploration*. Harcourt, Brace & Co., N. Y. 1928.) He noted the development of various traffic-attracted establishments—billboards, "hot dog" stands, filling stations, garages, stores, taverns, as well as the residences of people with jobs in the city, and part-time farmers. Farmers and others found it profitable to sell from wayside stands, build tourist

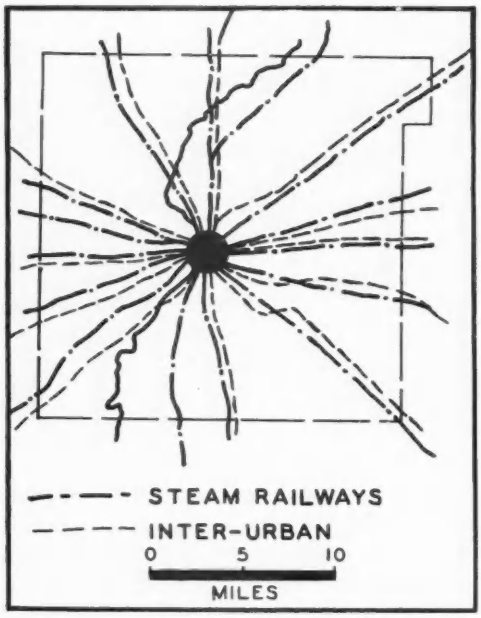

FIGURE 3.—Radiating pattern of steam railways and electric interurban lines, Marion County, Indiana, 1914. (From *The Library Atlas of the World.* Vol. I. *The United States.* Rand McNally & Co., 1914.)

cabins, advertise "rooms for tourists" or start a "soft drink" stand. The metropolitan invasion not only engulfed the land adjacent to the main highways but transformed the outlying rural villages. MacKaye deplored this invasion and hoped to regulate it and confine it to certain areas so as to maintain the rural indigenous landscape everywhere else. He states, "This invasion would take its start from the central community. Its movements here as elsewhere we may liken to a glacier. It is spreading, unthinking, ruthless. Its substance consists of tenements, bungalows, stores, factories, billboards, filling stations, eating stands, and other structures whose individual hideousness and collective haphazardness present that unmistakable environment which we call the 'slum.' Not the slum of poverty, but the slum of commerce. This substance, conceived as a projecting, crawling glacial flow, makes its journey along each of the radiating highways. The twenty rural villages of our locality are penetrated one by one. They are welded together into a common suburban mass without form or articulation; the integrity of each former village (each former human unit) is ironed away; its local government is merged in general administration; its 'personality' evaporates. Beyond the villages, the lines of flow, growing thin and puddly, continue their inroad toward the hinterland. In this wise the 63,000 souls become distributed in one continuous mass of straggling lines emanating from an overgorged center. These souls live all in a single environment: not city, not country, but wilderness—the wilderness not of an integrated, ordered nature, but of a standardized, unordered civilization. We have named this the metropolitan environment."

Almost as soon as railways became established, industries began to "decentralize" by seeking locations in the suburban areas. This has been accelerated by the modern highway and truck traffic. The availability of transportation, cheaper land, lower taxes and less control over land uses in rural areas, have been important inducements for industries to locate there or even to move from the city into the fringe. Thus another invasion of the metropolis is generated more or less paralleling lines of transportation. Sometimes this helps to build satellite towns, in other cases trailer towns, shack towns and slum-like residential areas accompany railroads and industrial outthrusts.

Summarizing, the structure of simple agricultural zones about the city has been transformed. Wherever a railway, an interurban line or a highway enters the city, residences, commercial establishments and industrial plants follow like water flowing through a break in a reservoir, an apt illustration used by

MacKaye. Since these means of transportation radiate in all directions whenever physical features do not interfere, the rural-urban fringe consists of rural territory pierced by finger-like projections of urbanized land uses. It has long been observed that cities have become star-shaped. In between the arms of the star, agriculture and other non-urban land uses continue but in more or less modified form.

RESIDENTIAL EXPANSION INTO THE FRINGE

Motor transportation has released man from the necessity of living in places where mass transportation is available. According to *Automobile Facts* of March, 1941 (published by the Automobile Manufacturers Association), there are 2,130 places in the United States with a total population of 12,000,000 people, ranging in population from 2,500 to 50,000, that depend exclusively on private cars. In other words, these cities have no street cars or buses of any type. Added to these are the millions in other cities, who though mass transportation is available, nevertheless depend largely upon private automobiles. These dwellers of the city and the fringe are independent of trains, street cars, and buses. As a result, cities have not merely expanded, they have "exploded." "Realtors" began to lay out subdivisions. The open country features of suburban living, lower taxes, fashion, and prestige not merely attracted the "surplus" population but began to invite and allure the established residents of the city itself. This has tended to leave behind empty houses, if not "blighted areas," certainly lower and lower land values. This almost self-evident trend has only recently attracted the attention of planners, lending agencies, and city officials. It was noticeable before 1930 but the 1940 census showed that while the 92 largest cities of the United States gained 1,600,000 people between 1930 and 1940, the remainder of the counties in which they are located gained almost the same, or 1,500,000 people. While the central cities gained four per cent the suburban areas of these cities gained fourteen per cent. Some of our largest cities, including Philadelphia, Boston, and Kansas City, actually lost population.

The wild expansion or "explosion" of the cities has also produced wildcat and premature subdivisions, over-expansion of residential sites, miles of sidewalks running through weed-covered vacant land, and clouded titles on thousands of vacant lots. Moreover, much of this "developed" area has been supplied with streets and sidewalks, water, sewers, gas, and electricity, schools and other public facilities at private or public expense. As long as this land is part of a rural unit of government, farms and other non-urban land are taxed as well as the "urban land" for these services either by the regular taxing machinery or through specially created districts. Unsold and unused lots often failed to pay taxes, and then the burden for the support of unused facilities has fallen on the remaining taxpayers. The rural land instead of gradually ripening into urban uses has been "forced" into urban uses prematurely and "frozen" there. Only rarely can such land be restored to agricultural use; thus we have created an "institutional desert." Land which according to its location should be growing the crops of von Thünen's first zone is lying as idle as the cut-over lands on the farm-forest fringe. It is reported that a farmer wishing to establish a poultry farm in the New York–New Jersey area had to go 80 miles from the city before he could find a tract of land

TABLE I

GROWTH OF POPULATION IN THE INDIANAPOLIS METROPOLITAN DISTRICT AND MARION COUNTY, INDIANA, 1910–1940[1]

	1910	*Per cent*[2] *Gain*	*1920*	*Per cent Gain*	*1930*	*Per cent Gain*	*1940*	*Per cent Gain*
Indianapolis	233,650	38.1	314,194	34.5	364,161	15.9	386,972	6.3
Incorporated Areas	3,024	−4.2	5,557	83.8	8,863	59.5	11,462	29.3
Unincorporated Areas	22,709	9.6	24,117	6.2	44,661	85.2	56,923	28.9
Total Metropolitan District	259,383	34.4	343,868	32.6	417,685	21.5	455,357	9.0

[1] *Metropolitan Districts*, Bureau of the Census, 1932 and other U. S. Census publications.
[2] Gain or loss 1900–1910.

not blighted by tax delinquency and clouded titles.

Residential developments in the fringe area must rely on rural form of government to furnish urban services such as streets, sidewalks, fire protection, water, and sewage disposal. Usually rural towns, counties, and precincts have no legal powers to do so. Sometimes the statutes are amended to give these rural units of government, unincorporated villages, or special districts the necessary authority to cope with these problems. In most cases, however, whenever residential areas have sufficient population they incorporate as separate villages or cities in order to handle their own affairs and to raise and spend their own tax money for services they need and desire. In this way satellite and neighboring villages and cities arise in the fringe. Some of them are of the manufacturing type with residences surrounding a factory, others are simply residential, "bedroom," or "dormitory" cities where people live who work in the city. These villages and cities depend not only on the main city for jobs but for most of their shopping, pleasures, and educational facilities, thereby generating a daily stream of traffic between the central city and its satellites in the fringe area. Thus another set of urban centers is created not contemplated in von Thünen's or Christaller's schemes but definitely modifying the land uses and the transportational system of the fringe. The relations of the urban residents living in the fringe (whether living in the unincorporated places or in incorporated villages and cities) to the central city, are very complex and must be omitted from a discussion limited to the physical structure of land uses in the fringe.

THE RURAL-URBAN FRINGE AROUND INDIANAPOLIS, INDIANA

The metropolitan district of Indianapolis may be used to illustrate many of these points. The district consists of seven of the nine townships which make up Marion County (Figure 4). The metropolitan district includes "the central city or cities, all adjacent and contiguous civil divisions having a density of not less than 150 inhabitants per square mile and also, as a rule, those civil divisions of less density that are *directly* contiguous to the central cities, or are entirely or nearly surrounded by minor civil divisions that have the required density." Using the same area for previous census periods the change in population of Indianapolis, of the other incorporated places, and of the unincorporated area may be traced as shown in Table I.

In 1870 Marion County had only one incorporated place—Indianapolis, a city of 48,000, located in Center township. (Indiana incorporated places are called *towns* or *cities;* unincorporated area is divided into *townships*.) By 1880 four

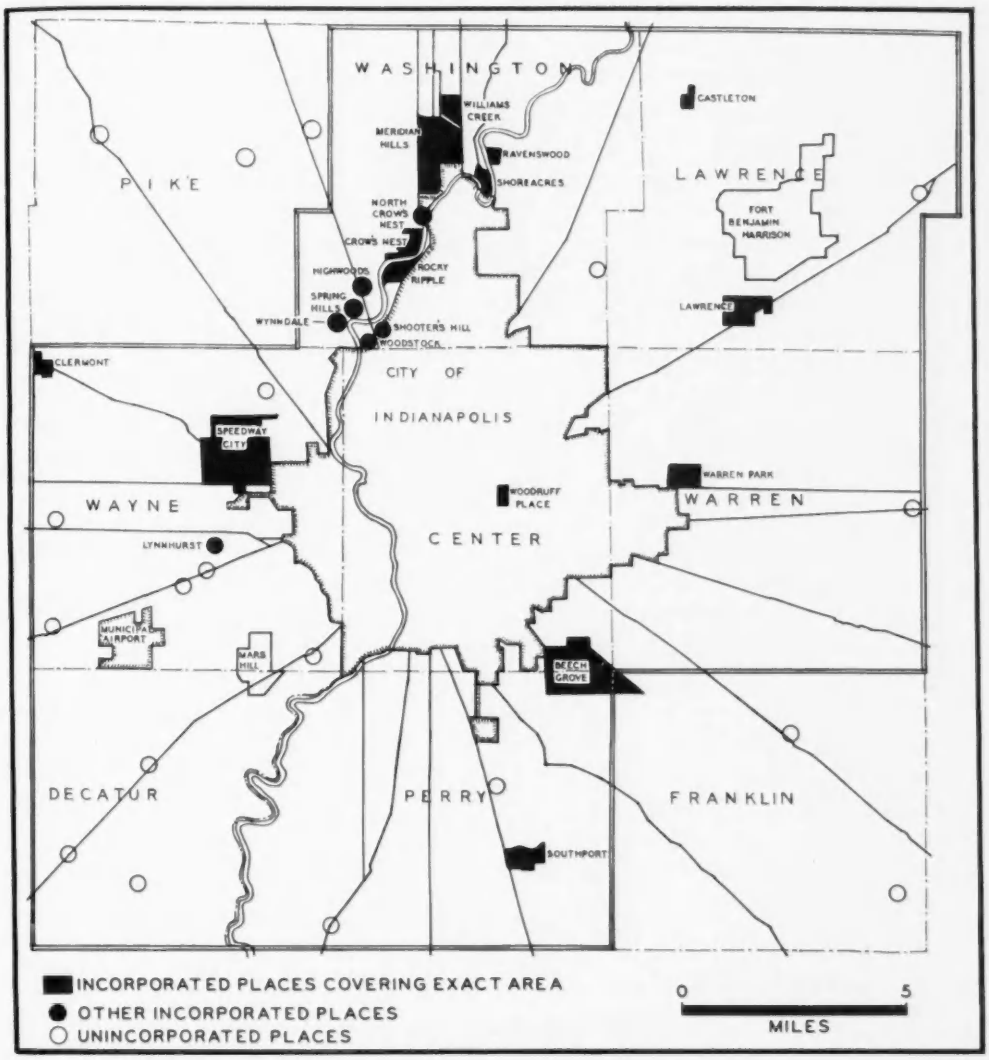

FIGURE 4.—The metropolitan district of Indianapolis, Indiana. The district embraces all of Marion County except Pike and Franklin Townships. The highly irregular boundary of Indianapolis and projections, such as the one into Perry Township, indicate the manner in which the city has annexed territory from the rural-urban fringe. The municipal airport is a legal part of Indianapolis. The area of some of the incorporated places is so small as to be lost on a map of this size; they are indicated by circles. The larger towns and cities are shown by the areas occupied; unincorporated places are shown by open circles, except Mars Hill. Only the main highways are placed on the map. (Based on the "Map of Marion County, Indiana" by Paul R. Brown, County Engineer, March 1, 1941, who also furnished information on the boundaries of incorporated areas.)

other places had incorporated, including Woodruff Place, situated in the heart of Indianapolis, which has maintained its separate existence to this day. The other incorporation of this period, Southport, is typical of several other towns located some distance from Indianapolis; all of them have grown rather slowly. Southport had 388 people in 1880 and 549 in 1940. Most of the incorporations, however, took place in the immediate rural-urban fringe, and since 1890 Indianapolis has annexed and absorbed seven of them. Eleven incor-

porations took place between 1920 and 1930 and two in the last census decade, practically all of them just outside of the city limits. According to Figure 4 several more places have incorporated since 1940. Some of them are very small, having in 1940 as few as 19, 21, or 30 people. (Small areas and population groups may no longer incorporate. The 1941 legislature of Indiana in Chapter 69, Section 1, now provides that not less than 250 people with at least one person for each four acres may incorporate.) Because of annexation to Indianapolis incorporated places actually lost population from 1890 to 1910; after that the gain was remarkable—84 per cent from 1910 to 1920, over 59 per cent in the next decade, and 29 per cent between 1930 and 1940.

However, these figures do not give a complete picture of urbanization of the District. Many people are living in densely settled but unincorporated places as shown in Figure 4. Traffic maps prepared by the Indiana Highway Commission in coöperation with the United States Bureau of Roads in 1937 list 15 unincorporated places with a total population of 12,738, 2,806 dwellings, and 241 business places; also, 18 subdivisions with 1,297 dwellings. Some of these unincorporated places have more population than the incorporated towns and villages. Mars Hill, for instance, had 2,580 people in 1937, more than any town or city except Beech Grove and Indianapolis. These figures are not complete. In a few cases either the population or number of dwellings was not given. Only dwellings were reported for the subdivisions. All subdivisions within Indianapolis or other incorporated places and the two townships not in the metropolitan district are not included in the above.

The unincorporated area increased but slowly in population until 1920, in fact actually decreased from 1900 to 1910. Figures of this type are deceptive, however. As soon as an agglomeration of people appears they may incorporate as a town or may be annexed to an existing town or city and the remainder of the area is left with fewer people than at the previous census enumeration. Indianapolis has consistently annexed unincorporated territory, at first only from Center Township, but as Figure 4 shows the city has invaded every bordering township. In spite of losses by annexation or incorporation the result of decentralization into the unincorporated area has been remarkable since the last World War. Population increased 85 per cent between 1920 and 1930 in the unincorporated area and 29 per cent during the next decade. Even the two townships not included in the Metropolitan District, which in 1920 actually had fewer people than in 1870, gained appreciably in the past 20 years. The unincorporated places, subdivisons and single residences strung along the highways are responsible for most of the increase.

The urbanization of Marion County is interestingly indicated by the fact that in Warren Township the east and west country roads all bear the name of those streets of Indianapolis with which they connect, while the north and south roads in the eastern part of the town still bear rural names such as the Mitthofer, German Church, and Fort Roads. City street names are found in the unincorporated areas of most of Washington, Wayne, and even in Pike Township but to a less extent in the three southern townships.

RECREATIONAL FEATURES IN THE "FRINGE"

The land uses of the fringe are also conditioned by the recreational needs of the urban people and by the people

living within the region as a whole. Planners envision parks, playgrounds, beaches, parkways, golf grounds, and forests within driving distance from the central cities to provide part of the indigenous environment contemplated by Benton MacKaye. The Forest Preserves of Chicago are a modern adaptation of von Thünen's forest zone but for recreational purposes entirely. "It has been suggested that an area equal to that occupied by urban developments should be accessible for public recreational activities within 100 miles of each great city," or a total of over nine million acres for the United States, "part of which is already available in city, metropolitan, and state parks or reservations."

To carry out this ideal means large scale metropolitan regional planning and the allocation of land to public recreational uses, most of it lying in the near-by fringe area so as to be accessible to people who can afford only a few hours' or a day's outing. However, land available for this purpose lies in the jurisdictions outside of the cities, and the rural governments are in no position to furnish and maintain public recreational facilities for the benefit of the hordes from the cities. Metropolitan districts, counties, the state, and perhaps even the federal government must share in providing these recreational lands.

Unfortunately most of the natural features suitable for recreation within the fringe area have long been preempted for private use. Riparian land along lakes and streams is covered with summer cottages, resorts, taverns, dance halls, and "Coney Islands." Roads leading to such resort areas are lined with the same type of amusement places. Private farm land is overrun by city "sportsmen" who claim the right to roam over the farms in the fringe within easy driving distance of the city. Nowhere are the conflicts between landowners and the alleged rights of the public more acute than in the areas adjacent to our cities. Farmers have posted their lands and towns and counties have found it necessary to prohibit shooting entirely.

INSTITUTIONAL FACTORS CONDITIONING FRINGE LAND USES

Finally, the land uses in the rural-urban fringe are also the result of institutional and legal factors. It has long been the practice of cities to "dump" unwanted yet necessary industries into rural territory by ordinances excluding them from the cities *per se*. Slaughter houses, wholesale oil storage, noxious industries of all sorts, junk yards, trailers and trailer camps, taverns and dance halls, substandard dwellings, carnivals, and the sale of firecrackers have all been the subject of restrictive city legislation at one place or another. Such establishments or land uses escape urban restrictions by locating in the country where rural governments are too feeble, or too apathetic to do anything about it. Some of the city's own public utilities are likewise placed in the fringe area or beyond; recreation, water supplies, radio towers, sewage disposal plants, airports, cemeteries are among urban necessities found in the suburban areas. There is a bit of poetic justice in the Jefferson County, Wisconsin, zoning ordinances which prohibit most of these uses in the "conservancy districts" and some of them even in the "agricultural districts." The only place left for them is in the incorporated places without zoning ordinances of their own! Using such maps as were available the writer noted 43 "facilities" of various types in the Indianapolis metropolitan district located in the unincorporated area, most

of which are associated with the activities of those living in Indianapolis, although some are state institutions such as the Indiana School for the Blind, or federal, as Fort Benjamin Harrison. The most numerous were country clubs, schools, airports, cemeteries, and "institutions." Eleven were situated right on the edge of Indianapolis, nine within one mile, eight within one to two miles, another eight were located more than two but less than four miles from the city limits and the others were "farther out." It was interesting also to find eighteen institutions, golf courses, parks and cemeteries just inside of the present boundaries of the city absorbed from the rural-urban fringe by annexations. The Indiana State Fair Ground is an example. In some cases such factors become the nucleus for urbanization. The famous Indianapolis Speedway is now part of Speedway City, incorporated in 1921.

In conclusion, the rural-urban fringe is really an extension of the city itself, actual and potential. It is an area where most of the land uses are in a flux and therefore subject to planning, direction, and control. A considerable proportion of the land in the built-up city is already dedicated to various uses and planning can be little more than replanning, and zoning must recognize the existing industrial, commercial, and residential districts. Unfortunately much of the land in the rural-urban fringe is already "frozen" with lot sizes, streets, and public utilities the result of haphazard growth or the decision of a speculative subdivider.

Since the city or cities of a metropolitan area and the suburban or fringe area are a unit economically and sociologically, the entire area should be thought of and planned as a unit. Within this region there should be a proper place for every structure and land use needed by people living therein. The lowly and despised junk yard has become a vital element in national defense and deserves a place in the regional plan just as much as the "high class" residential area. This place is not found by zoning it out of "higher" land use districts. Much of our planning and zoning has been inadequate because it sets up a hierarchy of land uses leaving farm land and other non-urban land as a residual or as an unrestricted area upon which everything may be unloaded.

County zoning has made a beginning in directing and controlling the land uses of the rural-urban fringe; in fact, the first enabling acts were designed for this particular purpose, notably in California and Wisconsin. In the latter state the zoning statute has been amended to permit the restriction of the use of land for agriculture, forestry, and recreation and the control of all forms of riparian land. Twenty-five counties have "rural zoning" ordinances of this type. Planners have felt that this was a distinct contribution to the zoning of the rural-urban fringe since it gives power over all types of land and not only the urbanized forms of land use. Combined with other directional measures, such as subdivision control, platting control, health and sanitary codes, many of the cities and counties of the United States now have the power to prevent haphazard, unharmonious, and incompatible land uses in the rural-urban fringe. However, mere power does not carry with it the desire, courage, or the wisdom necessary to make for a well planned rural-urban region and the proper structure of land uses in this transitional area.

AGRICULTURAL REGIONS OF AFRICA

PART III. PRESENT AND POTENTIAL PRODUCTIVITY OF THE LAND

H. L. Shantz

FOR twenty-three of the fifty-two colonies and countries we have fairly reliable figures of the amount of land capable of crop production, population, number of animal units, value of agricultural exports, and tax on natives. Undoubtedly the inclusion of tax on natives throws some of the colonies into a too favorable position. This is true for the North African colonies where a sharp distinction cannot be made between native and European taxations, and Algeria, Egypt, Morocco, and Tunis rank high partly on this account. These measurements can be combined in a loose way to give the ordered arrangement shown in Table A, arrived at by averaging the rank in each column.

The Union of South Africa and Nigeria lead, the former, despite its eighth position in the amount of land capable of crop production and its fourth position in tax on natives and in population, ranks high in animal units (Figure 218) and in export of agricultural products.

Nigeria never falls below fifth place. It leads in population, is fourth in land capable of crop production and in agricultural exports, and fifth in animal units and tax on natives. This is remarkable since it is a native country and has no European occupancy.

Algeria and Tanganyika are next. Algeria leads in tax on natives, is third in agricultural exports, fifth in population, and seventh in animal units, but falls to fourteenth place in land suitable for crop production. Algeria, like the Union of South Africa, has apparently made good use of its crop lands. Tanganyika stands third in animal units (Figure 219), fifth in land capable of crop production, but ninth in agricultural exports, and seventh in population.

Morocco is fifth, but stands third in tax, twelfth in land, fourth in animal units, and fifth in agricultural exports. This again indicates efficient use of land. The Anglo-Egyptian Sudan is sixth in the list. It stands second in amount of land capable of crop production, but is relatively low in tax, animal units, and agricultural exports. Here the indication is that lands are not developed. An additional factor is that the land is far from transportation facilities.

Egypt, almost at the bottom of the list in the amount of productive land, is seventh, due partly to its position at the top of the list of agricultural exports, and second in tax and population. Here is land highly developed and highly productive, chiefly of crops which are grown both winter and summer (Figure 220). Since grazing land sufficient to maintain herds of domestic animals is not available adjacent to the rich crop lands, it stands ninth in animal units. Madagascar, in eighth position, is second in number of animal units, but low in taxes and agricultural exports.

An examination of Table A will show a number of startling departures. The Congo, in tenth position, is first in land suitable for crop production. This is

due to the fact that so much of the area is in virgin forest or in native grassland or, in other words, is not agriculturally developed. Its population is also third which means probably that on its land under cultivation much of what is produced is consumed locally (Figure 221). Export, tax, and animal units (Figures 222 and 223) are low. Kenya, eleventh, is relatively low in potential crop land but is high in animal units and tax on natives. Angola, in twelfth place, nineteenth, is high in exports and population. Bechuanaland, twentieth, is high in land area. Urundi–Ruanda is high in animal units (Figure 228) and population. French Togoland and Swaziland, two small countries, complete the list.

On the basis of land capable of agricultural production, the Congo, Anglo-Egyptian Sudan, Angola, Nigeria, and Tanganyika lead, followed by Portuguese East Africa, Northern Rhodesia, Union of South Africa, and Madagascar.

FIGURE 218.—The Union of South Africa leads in the production of domestic livestock. In the cooler portions European breeds have replaced the native animals. Here goats are seen using the desert shrubs and acacia of the Karroo near Beaufort West, Cape Province, Union of South Africa.

is third in land area, and it is not highly developed.

Tunis, thirteenth, is sixth in agricultural exports, but low in potential crop land. Southern Rhodesia, fourteenth, is low in population, and high in animal units (Figure 224) and potential crop land (Figure 225). Portuguese East Africa is high in potential crop land and low in exports and animal units, while Northern Rhodesia, sixteenth, is high in potential crop land and low in exports, tax on natives, and population. Basutoland, seventeenth, is high in animal units (Figure 226) and tax, but low in land and population. Nyasaland is eighteenth (Figure 227), and rather evenly balanced, while Sierra Leone, The bottom of the scale has Swaziland, Egypt, Basutoland, Tunis, and Urundi–Ruanda, largely due to their small areas.

On the basis of population, the order is somewhat different. Nigeria leads, followed by Egypt, Congo, Union of South Africa, and Algeria. Of these, Nigeria and the Congo are in the first five in agricultural land, but Egypt is in the lowest five. These are followed by the Anglo-Egyptian Sudan, Tanganyika, Morocco, and Madagascar, two of which occurred in the first group when arranged on the basis of agricultural land.

At the bottom of this list are Swaziland, Bechuanaland, Basutoland, French Togo, and Southern Rhodesia.

TABLE A

COMPARISON OF 23 COLONIES AS TO LAND CAPABLE OF CROP PRODUCTION, POPULATION, NUMBER OF ANIMAL UNITS, VALUE OF AGRICULTURAL EXPORTS, AND TAX LEVIED ON NATIVE PEOPLES, ARRANGED IN DECREASING RANK. BRACKETED COLONIES HAVE THE SAME RANK

	Land Capable of Crop Production in 1000 sq. mi.	*Rank*	*Population in 1000*	*Rank*	*Animal Units in 1000*	*Rank*	*Agricultural Exports in $1000*	*Rank*	*Tax on Natives in $1000*	*Rank*
1. Union of South Africa	257	8	7,086	4	23,337	1	141,685	2	5,763	4
2. Nigeria	327	4	19,592	1	5,082	5	73,802	4	4,004	5
3. Algeria	59	14	6,063	5	3,732	7	131,114	3	31,909	1
4. Tanganyika	299	5	4,825	7	5,925	3	17,784	9	3,644	6
5. Morocco	93	12	4,229	8	5,428	4	39,865	5	6,372	3
6. Anglo-Egyptian Sudan	448	2	5,484	6	3,120	8	23,729	7	2,243	11
7. Egypt	10	22	14,213	2	2,860	9	261,758	1	29,124	2
8. Madagascar	233	9	3,621	9	7,040	2	12,641	10	1,803	12
9. Uganda	73	13	3,411	11	2,471	11	20,486	8	2,791	7
10. Congo	909	1	8,723	3	599	17	11,795	12	621	17
11. Kenya	56	15	2,984	12	4,216	6	11,855	11	2,626	9
12. Angola	445	3	2,522	13	1,216	14	6,342	15	2,254	10
13. Tunis	17	20	2,160	14	1,359	12	32,330	6	2,699	8
14. Southern Rhodesia	149	11	1,033	19	2,728	10	10,822	13	1,750	13
15. Portuguese East Africa	289	6	3,516	10	528	19	370	22	1,262	14
16. Northern Rhodesia	278	7	1,309	18	641	16	665	21	602	18
17. Basutoland	12	21	498	21	1,291	13	4,932	16	690	15
18. Nyasaland	38	16	1,360	17	225	21	2,865	18	624	16
19. Sierra Leone	29	17	1,536	15	48	23	6,416	14	377	19
20. Bechuanaland	175	10	153	22	582	18	1,344	19	200	22
21. Urundi and Ruanda	19	19	1,500	16	903	15	333	23	207	20
22. Togoland, French	21	18	559	20	65	22	3,200	17	104	23
23. Swaziland	7	23	113	23	246	20	919	20	206	21

On the basis of animal units the Union of South Africa stands out prominently. Madagascar is second with only a third as many. Tanganyika is next, followed by Morocco, Nigeria, Kenya (Figure 229), Algeria, and the Anglo-Egyptian Sudan. Egypt is next, followed by Southern Rhodesia, Uganda, Tunis, Basutoland, and Angola. Countries of lower production are Urundi–Ruanda, Northern Rhodesia, Congo, Bechuanaland, Portuguese East Africa, Swaziland, Nyasaland, French Togo, and Sierra Leone. Even in this lower group cattle are important in Urundi–Ruanda (Figure 228), Northern Rhodesia, Bechuanaland (Figure 226), and Swaziland.

Agricultural exports are important in measuring the agricultural significance of a country to the commercial world and in evaluating present production. However, a country may be very rich agriculturally and consume most of the produce. On the basis of exports, Egypt stands out above all other countries. Land areas although small are unusually productive and are productive throughout the whole year. No cold or drought rest period curtails the constant production of plant products (Fig-

FIGURE 219.—Livestock is an important contribution in Tanganyika Territory. Here cattle are grazing near the coast in groves of coconut palm. The cattle are of the zebu type Dar-es-Salaam, Tanganyika.

FIGURE 220.—Although cotton and onions rank higher as exports, sugar cane is an important crop in the Nile Valley. Here extensive acreages are shown. Luxor, Egypt.

ure 220). The Union of South Africa is next followed closely by Algeria which it resembles in its sub-tropical agriculture. Nigeria, next, is distinct in that its agriculture is entirely native. Morocco, next, is followed by Tunis, Anglo-Egyptian Sudan, Uganda, Tanganyika, Madagascar, Kenya, Congo, Southern Rhodesia, Sierra Leone, Angola, Basutoland, French Togo, and Nyasaland. Bechuanaland, Swaziland, Northern Rhodesia, and Urundi–Ruanda end the list.

In tax, Algeria, Egypt, and Morocco lead, partly due to the difficulty of distinguishing between Europeans and natives in taxation. The Union of South Africa follows with Nigeria in fifth place and Tanganyika sixth. Uganda, Kenya, Angola, and the Anglo-Egyptian Sudan produce substantial returns in taxation on natives. Outstanding colonies are the Congo and Northern Rhodesia which are low, and Algeria, Egypt, and Morocco which are high.

Probably a better comparison could be made if it were based on land capable of crop production, population, and agricultural exports, or only on population and agricultural exports alone. In the following lists the 23 colonies are arranged according to their ranking on the basis of the column headings.

The Union of South Africa and Nigeria lead the first list, and the former

FIGURE 221.—The rich and varied culture of the Congo is shown here. At the side of the hut is colocasia, tobacco, castor oil bean, citrus, bananas, papaya, oil palm, and sugar cane. Kongolo, Belgian Congo.

(1) *Based on Land Capable of Crop Production, Population, Animal Units, Agricultural Exports and Tax on Native Peoples*	(2) *Based on Land Capable of Crop Production, Population, and Agricultural Exports*	(3) *Based on Population and Agricultural Exports*
1. Union of South Africa	Nigeria	Egypt
2. Nigeria	Union of South Africa	Nigeria
3. Algeria	Anglo-Egyptian Sudan	Union of South Africa
4. Tanganyika	Congo	Algeria
5. Morocco	Tanganyika	Morocco
6. Anglo-Egyptian Sudan	Algeria	Anglo-Egyptian Sudan
7. Egypt	Egypt	Congo
8. Madagascar	Morocco	Tanganyika
9. Uganda	Madagascar	Uganda
10. Congo	Angola	Madagascar
11. Kenya	Uganda	Tunis
12. Angola	Kenya	Kenya
13. Tunis	Portuguese East Africa	Angola
14. Southern Rhodesia	Tunis	Sierra Leone
15. Portuguese East Africa	Southern Rhodesia	Southern Rhodesia
16. Northern Rhodesia	Northern Rhodesia	Portuguese East Africa
17. Basutoland	Sierra Leone	Nyasaland
18. Nyasaland	Nyasaland	Basutoland
19. Sierra Leone	Bechuanaland	Togoland, French
20. Bechuanaland	Togoland, French	Northern Rhodesia
21. Urundi and Ruanda	Basutoland	Urundi and Ruanda
22. Togoland, French	Urundi and Ruanda	Bechuanaland
23. Swaziland	Swaziland	Swaziland

In these lists there is considerable shifting about. However, of the lower 10 of the list in column one, 9 are found in column 2, and 10 in column 3. Of the upper 10 of column 1, 9 are found in column 2 and 10 in column 3. While they shift about the positions are usually not greatly changed. Column 3 would seem to indicate best the present position, but the others give undeveloped colonies better recognition on the basis of potential productivity.

falls one step in each succeeding column. This would seem to indicate potentialities not yet fully developed. Egypt on the other hand stands low in the first column but at the top of the third. It is a highly developed agricultural area which will probably not increase greatly beyond its present production, Nigeria near the top is a large productive land fully populated.

The Congo is low in the first list but high in the second because of its huge area of agriculturally potential land and population (Figure 221). Northern Rhodesia is low in the third column but higher in the first which might indicate potential production far above that at present achieved. Sierra Leone is the reverse, standing high in the third column. Tanganyika is low in the third column, indicating potentialities of greater production.

In considering the arrangement in column three, Egypt is in many ways in a class by itself and stands out in production above all others. Nigeria is likewise a rich country developed by natives to a highly productive state. The Union of South Africa is much like a European country or the United States of America. It is extremely varied as to types of country and has a diversified agriculture. Algeria and Morocco similar physically to South Africa and to California are rich and varied. The Anglo-Egyptian Sudan and Belgian Congo are largely undeveloped areas but because of their size relatively productive of export goods and populations. Tanganyika (Figure 230) exceeds Uganda and Kenya (Figure 231) because of size, which also is a factor in the favorable position given to Madagascar. Tunis is small but highly productive when measured in terms of population supported or products exported.

Kenya, a varied country relatively

FIGURE 222.—Goats survive in tsetse fly areas. Goats and chickens are the chief domestic animals of this part of the Congo. Bukama, Belgian Congo.

well developed, is followed in the list by Angola much larger in agricultural land and by Sierra Leone much smaller in agricultural land, then by Southern Rhodesia and Portuguese East Africa. Nyasaland is next, much smaller than Kenya, but larger than Basutoland which stands out as a productive area. French Togoland, a small area, exceeds Northern Rhodesia, a very large area of agricultural land. Urundi-Ruanda is also small but exceeds Bechuanaland where much of the land is semi-arid. Swaziland ends the list largely because of the small area.

The colonies here considered, as arranged in column 3 (Figure 232), mark out certain areas such as the Nile Valley and the East African Highland, much of Central and South Africa, North Africa, Nigeria, and Madagascar on the basis of population and agricultural exports.

From this comparison, it is evident that the productive colonies are located in the desert with irrigation (Egypt) in temperate South Africa and North Africa, and in tropical Africa (Nigeria). It also indicates that the great central part at high elevation is productive if measured either in population supported or in agricultural exports. It also indicates the productive richness of such tropical areas as Nigeria and the Anglo-Egyptian Sudan, the Congo, Uganda, Tanganyika, Kenya (Figures 221, 230, 231, 233, 234, and 235), and Sierra Leone.

This rough summary has been made in order to secure an evaluation figure for the different colonies. These can only be summarized in general terms, and are not means of evaluating land as such since a great factor in arranging them on the total of exports, population, or agricultural land, is determined by the size of the colony. In order to overcome this difficulty, the data have been summarized in Table B in such a way that the size of the area is entirely eliminated.

In Table B is shown the same group of colonies included in Table A, but here arranged on the basis of the square mile rather than total area, and on the tax per native, rather than total taxation. This is done in order to estimate the productive capacity of land independent of the area. In this table, Egypt stands out above all other areas, since the large areas of desert land are eliminated and production is based only on the rich irrigated land of the Nile Valley (Figure 220). Even here it is hardly fair to compare land farmed

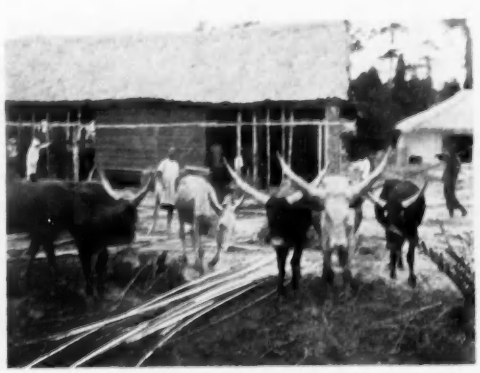

FIGURE 223.—In the cities in the tropical rain forest a few cattle are found. These are of the large-horned zebu type. Kindu, Belgian Congo.

under natural rainfall with that supplied by irrigation. Algeria would stand next to Egypt if it were not for the inclusion of the animal unit estimates which for Algeria include great areas of desert land of low carrying capacity. Algeria leads Tunis in agricultural exports per square mile of agricultural land and also in tax collected per square mile of agricultural land. Basutoland stands fourth. This is surprising for it is a country in which the European plays almost no role at all. Moreover, while the whole country is classed on a rough basis, as agricultural land, much of it is too rough and rocky for that

TABLE B

COMPARISON OF 23 COLONIES AS TO VALUE OF AGRICULTURAL EXPORTS AND TAX ON NATIVES, AND POPULATION PER SQUARE MILE OF LAND SUITABLE FOR CROP PRODUCTION AND OF ANIMAL UNITS PER SQUARE MILE OF GRAZING LAND AND TAX ON NATIVES

	Agri. Exports Per Sq. Mile Agri. Land in Dollars	*Rank*	*Tax on Natives Per Sq. Mile Agri. Land in Dollars*	*Rank*	*Population Per Sq. Mile Agri. Land*	*Rank*	*Animal Units Per Sq. Mile of Grazing Land*	*Rate*	*Tax Per Native in Dollars*	*Rate*
1. Egypt	26,176	1	2,912	1	1,420	1	10.4	13	2.05	2
2. Tunis	1,902	3	159	3	127	2	38	5	1.36	7
3. Algeria	2,222	2	541	2	103	3	5.4	15	6.14	1
4. Basutoland	411	6	57	5	42	10	106	1	1.39	6
5. Morocco	480	5	77	4	51	8	27	8	1.54	5
6. Union of South Africa	551	4	22	9	28	12	50	2	1.07	9
7. Uganda	281	7	38	7	47	9	31	7	0.82	12
8. Kenya	212	10	47	6	53	6	20	9	0.90	11
9. Swaziland	131	12	29	8	17	14	35	6	1.86	3
10. Nigeria	226	8	12	14	54	5	16.2	12	0.20	20
11. Southern Rhodesia	73	14	12	13	7.6	20	18.3	10	1.78	4
12. Urundi and Ruanda	18	18	11	15	79	4	43	3	0.14	22
13. Nyasaland	75	13	16	10	28	11	6.1	14	0.46	15
14. Tanganyika	59	15	12	12	16	15	16.7	11	0.76	13
15. Sierra Leone	221	9	13	11	53	7	2.3	20	0.25	19
16. Madagascar	54	16	7.7	16	15	16	39	4	0.50	14
17. Togoland, Fr.	152	11	4.9	17	27	13	3.1	17	0.19	21
18. Anglo-Egyptian Sudan	53	17	5.0	19	12	17	3.8	16	0.42	17
19. Angola	14	19	5.1	18	5.6	21	2.6	19	0.91	10
20. Bechuanaland	7.7	21	1.1	22	0.9	23	2.1	18	1.32	8
21. Portuguese East Africa	1.3	23	4.4	20	12	18	1.8	22	0.36	18
22. Northern Rhodesia	2.4	22	2.2	21	4.7	22	2.3	21	0.46	16
23. Congo	13	20	0.7	23	9.6	19	1.2	23	0.07	23

FIGURE 224.—Southern Rhodesia is a ranch country and cattle are used for transportation as well as for milk, meat, and hides. Ox teams are used extensively all over South Africa. These animals are largely of the Afrikander breed. Near Salisbury, Southern Rhodesia.

FIGURE 225.—Maize throughout much of Africa is a major crop. It is especially important in the ranch country. These fields are productive of food for man and beast. The meal is sold as mealies and even called "mealie meal" at times. Domboshawa, Southern Rhodesia.

purpose. It is badly overstocked with domestic animals and is a relatively densely inhabited country. It is in the cattle and cereal belt. Morocco, like Tunis and Algeria, stands high as a productive area. The Union of South Africa (Figure 218), an exceedingly varied country, is next, followed by Uganda, Kenya, Swaziland, Nigeria, and Southern Rhodesia (Figure 220 224, and 236). Urundi–Ruanda is a country dominated by natives and only a few Europeans have plantations there. Still it is a rich country, especially if measured in terms of population supported or animals produced (Figure 228). It falls low in exports and relatively low in taxation partly due to the low taxation rate and the low price of products, due to inaccessibility of markets. Nyasaland (Figure 227) is about equal in all of these measurements, but is a little high in tax on natives. Tanganyika (Figure 235), likewise, is about equally classed in all of these measurements. Sierra Leone is about equal but shows up well in export and population density, but low in animals produced. Madagascar stands high in animal units per square mile of grazing land but the other values are about equal. French Togoland is next followed by the Anglo-Egyptian Sudan and this in turn by Angola which is relatively high in tax per native. Bechuanaland is even higher in tax per native. This is largely due to the high tax on an almost exclusively cattle-raising people (Figure 226). Portuguese East Africa, Northern Rhodesia, and the Belgian Congo end the list.

The products of the land expressed as exports of agricultural products and also as population per square mile of agricultural land might give a truer value than when animal units and tax on natives are included. If the countries are arranged on this basis, the order is considerably altered.

Egypt again leads, followed by Algeria and Tunis. Algeria and Tunis are alike, but the large area of low carrying capacity grazing land throws Algeria below in the first list. Nigeria and Morocco are next in line, the low position of Nigeria in the first list being due to the low tax rate. Morocco has the same position in both lists as has also the Union of South Africa. They are both similar to California in variety of climate and character of land.

Kenya and Uganda rank with the Union of South Africa and all are exactly alike in both lists. Basutoland and Sierra Leone also rank with these colonies. Urundi–Ruanda is next, followed by Nyasaland and French Togoland which rank together, and by Swaziland. They are all small countries with no desert lands and are unusually productive.

Tanganyika and Madagascar are followed by Southern Rhodesia and the Anglo-Egyptian Sudan. These four are probably in this relatively low position partly because they have not been

1 *Agricultural Exports, Tax Population Per Sq. Mile; Agricultural Land, Animal Units Per Sq. Mile; Grazing Land and Tax Per Native*	2 *Agricultural Exports Per Sq. Mile of Agricultural Land, and Population Per Sq. Mile of Agricultural Land*
1. Egypt	1. Egypt
2. Tunis	2. Algeria
3. Algeria	3. Tunis
4. Basutoland	4. Nigeria
5. Morocco	5. Morocco
6. Union of South Africa	6. Union of South Africa
7. Uganda	7. Uganda
8. Kenya	8. Kenya
9. Swaziland	9. Basutoland
10. Nigeria	10. Sierra Leone
11. Southern Rhodesia	11. Urundi and Ruanda
12. Urundi and Ruanda	12. Nyasaland
13. Nyasaland	13. Togoland, Fr.
14. Tanganyika	14. Swaziland
15. Sierra Leone	15. Tanganyika
16. Madagascar	16. Madagascar
17. Togoland, Fr.	17. Southern Rhodesia
18. Anglo-Egyptian Sudan	18. Anglo-Egyptian Sudan
19. Angola	19. Congo
20. Bechuanaland	20. Angola
21. Portuguese East Africa	21. Portuguese East Africa
22. Northern Rhodesia	22. Northern Rhodesia
23. Congo	23. Bechuanaland

FIGURE 226.—View from the top of a hill showing huts with thatched roofs, mud fences and a stout cattle corral with the acacia desert grass grazing land in the back. This is a cattle country. Mochudi, Bechuanaland.

developed rather than because of low productive potentiality. The same applies to the Belgian Congo, Angola, and Portuguese East Africa. Bechuanaland which ends the list is largely semi-desert land. This method measures the productivity of agricultural land. It successfully eliminates size of colony and the non-productive lands and brings into line countries such as Kenya and Uganda, which differ chiefly in size and amount of desert land.

This distribution based on agricultural exports and population per square mile of agricultural land is shown graphically in Figure 236. If the graph is compared with Figure 232, it is evident that the large colonies such as the Anglo-Egyptian Sudan, Belgian Congo, Tanganyika, and Madagascar drop out of the first ten, and that Tunis, Kenya, Basutoland, and Sierra Leone take their place.

The lower ten in Figure 236 does not include Sierra Leone, Nyasaland, Basutoland, French Togoland, and Urundi–Ruanda. It does include, however, Tanganyika, Madagascar, Anglo-Egyptian Sudan, Belgian Congo, and Angola. In other words, the smaller countries are mile for mile of agricultural land producing more than the larger colonies which on the basis of totals ranked higher. Figure 236 shows countries of rich production per square mile of agricultural land, and Figure 232 countries of high productivity when measured in totals.

FIGURE 228.—Large horned cattle are typical of the tropical highlands of Tanganyika, Urundi-Ruanda, and Uganda. They are chiefly valuable for meat and hides. The amount of milk produced is very small. Nyanza, Urundi.

FIGURE 227.—In the highlands of Nyasaland almost anything will grow. Here are clumps of bamboo at the left and forest of eucalyptus at the right. Livingstonia, Nyasaland.

It is possible to compare these in still another way. Land capable of crop production is shown in the following tabulation in column 1. Column 2 is arranged on the basis of total agricultural exports and total population, and column 3 is based on agricultural exports and population per square mile of land capable of crop production.

In this arrangement the first column does not adequately consider the difference in the productivity of lands. It merely separates that capable of crop production and classes together rich alluvial river bottom land of Egypt with the semi-arid lands of Bechuanaland. However, it is a measure of potentiality and not influenced by present development. This list is headed by the Belgian Congo, much of which is still covered by virgin tropical rain forest, and is followed by the Anglo-Egyptian Sudan, a country ranging from

moist tropics to the semi-arid tropics. Angola, Nigeria, Tanganyika, Portuguese East Africa, and Northern Rhodesia likewise have large areas of land potentially capable of producing warm-weather crops. The Union of South Africa shows great variety of country and is semi-tropical. Madagascar which is at present largely grazed by cattle is mostly land capable of crop production. Bechuanaland could be variously classified. It is semi-arid grazing land for the most part and the great area probably can never be as intensively cropped as equal areas in Southern Rhodesia or even in the Anglo-Egyptian Sudan. Morocco and Algeria, like South Africa, have valuable lands of semi-tropical character. Uganda, Kenya, Nyasaland, Sierra Leone, Togoland French, Urundi-Ruanda, Tunis, Basutoland, Egypt, and Swaziland are at the bottom of the list not because of non-productivity of the agricultural land but because of the small acreage of such land.

This list tells nothing of developed land or amount of production. It merely lists the colonies in order of amount of land in a suitable climate for agricultural production.

FIGURE 229.—In Kenya cattle and sheep are important to Europeans but on the basis of totals most of them are native owned. Cattle are mostly of the zebu type. These are crossed with better European types to increase milk and beef production characteristic of the European breeds and to retain the hardiness of disease-resistance of the native stock. Kijabe, Kenya.

Actual productivity is indicated in the second column and here Egypt stands first although it was near the bottom of the first column. Since exports and population are based on totals, the size of the colony is an important consideration. Egypt is followed by Nigeria, the Union of South Africa, and Algeria. Morocco and Anglo-Egyptian Sudan, Belgian Congo and Tanganyika

1 *Land Capable of Crop Production*	2 *Total Agricultural Export and Total Population*	3 *Agricultural Export and Population Per Sq. Mile Agricultural Land*
1. Congo	1. Egypt	1. Egypt
2. Anglo-Egyptian Sudan	2. Nigeria	2. Algeria
3. Angola	3. Union of South Africa	3. Tunis
4. Nigeria	4. Algeria	4. Nigeria
5. Tanganyika	5. Morocco	5. Morocco
6. Portuguese East Africa	6. Anglo-Egyptian Sudan	6. Union of South Africa
7. Northern Rhodesia	7. Congo	7. Uganda
8. Union of South Africa	8. Tanganyika	8. Kenya
9. Madagascar	9. Madagascar	9. Basutoland
10. Bechuanaland	10. Uganda	10. Sierra Leone
11. Southern Rhodesia	11. Tunis	11. Urundi and Ruanda
12. Morocco	12. Kenya	12. Nyasaland
13. Uganda	13. Angola	13. Togoland
14. Algeria	14. Sierra Leone	14. Swaziland
15. Kenya	15. Southern Rhodesia	15. Tanganyika
16. Nyasaland	16. Portuguese East Africa	16. Madagascar
17. Sierra Leone	17. Nyasaland	17. Southern Rhodesia
18. Togoland, Fr.	18. Basutoland	18. Anglo-Egyptian Sudan
19. Urundi and Ruanda	19. Togoland, Fr.	19. Congo
20. Tunis	20. Northern Rhodesia	20. Angola
21. Basutoland	21. Urundi and Ruanda	21. Portuguese East Africa
22. Egypt	22. Bechuanaland	22. Northern Rhodesia
23. Swaziland	23. Swaziland	23. Bechuanaland

FIGURE 230.—A luxuriant planting of cassava, pepper, banana, and papaya. Here are also pumpkin, sugar cane, maize, sweet potato, yams, and many types of beans and other vegetables. Moshi, Tanganyika Territory.

follow, although very different in character, and these are followed by Madagascar and Uganda. Tunis, Kenya, Angola, and Sierra Leone are then followed by Southern Rhodesia and Portuguese East Africa. With the exception of Northern Rhodesia and Bechuanaland all are small countries.

In comparing the position of the colony in column 2 with that of column 1 we find Egypt has risen from twenty-second place to first place. Other increases are noted for Algeria, Tunis, Morocco, Union of South Africa, Uganda, Kenya, Sierra Leone, Basutoland, and Nigeria. Northern Rhodesia is seventh in column 1 and has fallen to twentieth place in column 2. Other colonies which also show unfavorably are Bechuanaland, Portuguese East Africa, Angola, Congo, the Anglo-Egyptian Sudan, Southern Rhodesia, and Tanganyika.

Since column 1 compares the position of colonies on the basis of total potential productive land and column 2 the total actual production, the second is in a way a measure of the degree to which each colony has realized its productive capacity.

In the third column size of colony is eliminated and production based on square mile of land capable of agricultural production. It measures more directly the productivity of the land and to some extent measures the degree to which these colonies have developed the land they have available. In other words, this third list indicates to a certain degree the approach which has been made to realizing the potential productivity of the various colonies. Egypt heads the list followed by Algeria, Tunis, Nigeria, Morocco, Union of South Africa, Uganda, Kenya, Basutoland, and Sierra Leone. At the bottom stands Bechuanaland followed in ascending scale by Northern Rhodesia, Portuguese East Africa, Angola, Congo, and the Anglo-Egyptian Sudan, Southern Rhodesia, Madagascar, and Tanganyika.

If column 2 and column 3 are compared, the emphasis is placed on production per unit area and the size of the colony eliminated. This consideration raises the position of the small productive colonies which often have produced dense populations and therefore produce great quantities of agricultural products in addition to those exported and which may have reached or approximated their potentialities.

FIGURE 231.—In the high country in Central Africa yams (*Dioscorea*) are important root crops. The vines cover small trees. Embu, Kenya Colony.

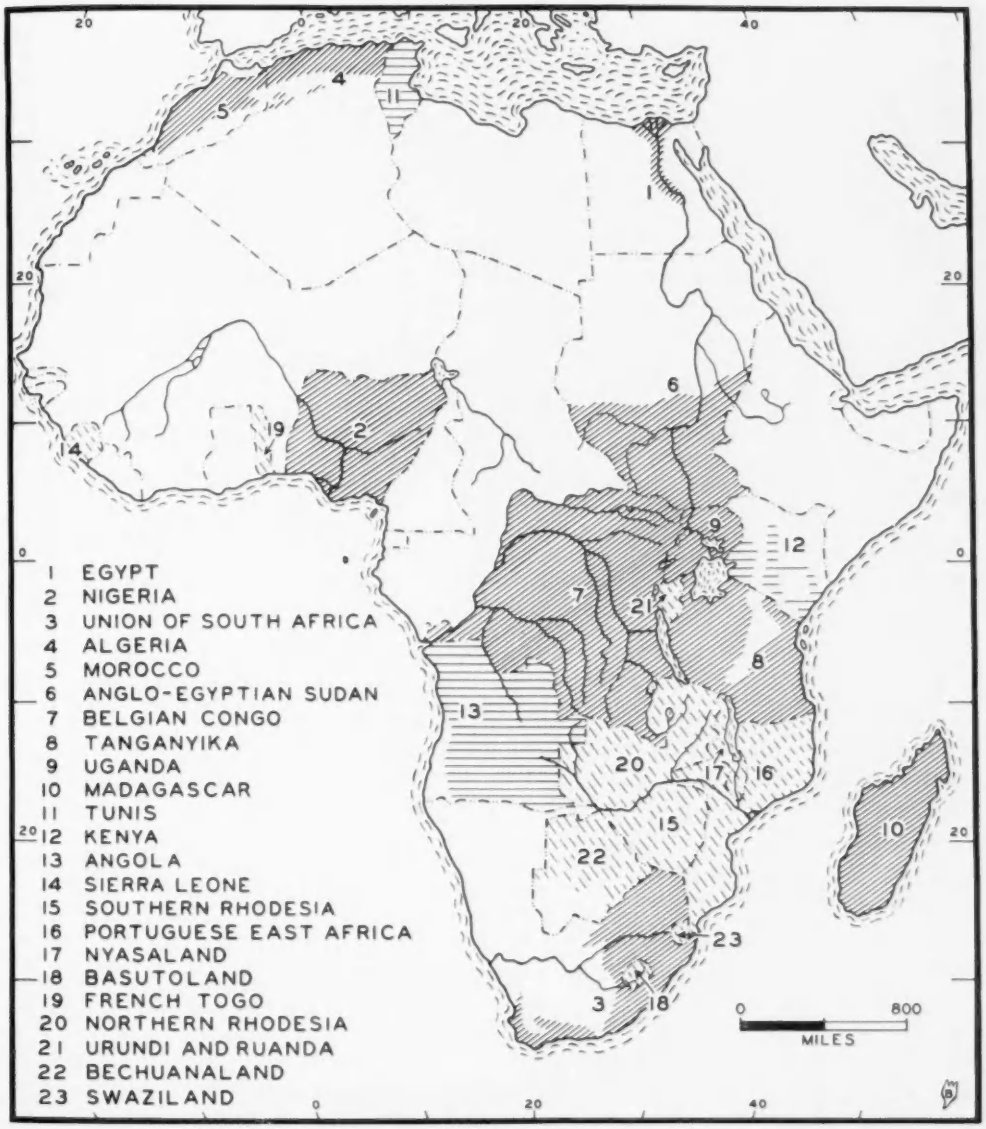

FIGURE 232.—The colonies listed in Table A, arranged on the basis of total population and total agricultural export. They are arranged in descending rank. The deepest shaded portion indicates the land most capable of crop production. The first ten are heavily shaded and the last ten lightly shaded. Numbers 11 to 13 are intermediate.

Lowered in position are those undeveloped countries which are far below their productive potentialities in population or export, or both.

The countries showing the greatest rise in position are Urundi–Ruanda, Basutoland, Swaziland, Tunis, French Togo, and Nyasaland. Those showing the greatest fall in position are Belgian Congo, Anglo-Egyptian Sudan, Angola, Madagascar, Tanganyika, and Portuguese East Africa.

This distribution of countries does not by any means cover the continent but it does give measuring sticks with which to evaluate adjacent lands. This

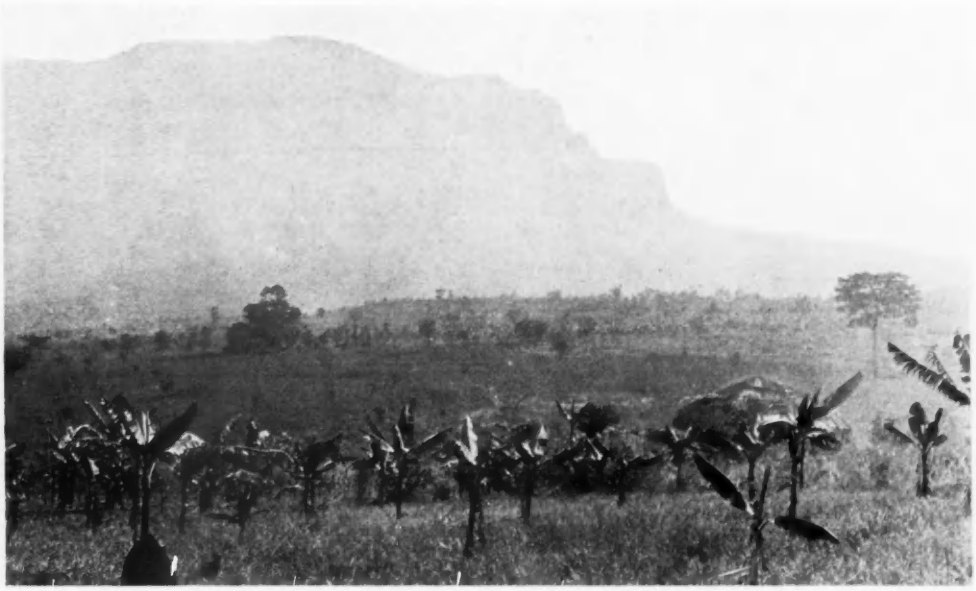

FIGURE 233.—A field of eleusine and banana with cotton behind it. The mountain in the background is M'Koko N'Jaru. Nebumale, Uganda.

is especially true if the native plant cover is used as a means of extending these better known areas to other lands less well known for which there are no adequate records of production and no means other than these of evaluating their agricultural potentialities.

In this skeleton of the African Continent other colonies could be fitted in on the basis of the partial information available.

Egypt is first and in a class by itself when it is judged on the basis of productivity per unit of land capable of crop production. Crops are produced under irrigation (Figure 220) and both summer and winter crops of great variety, both cool-weather and warm-weather crops. The exports are chiefly cotton, onions, rice, and maize.

Zanzibar would certainly stand next to Egypt both in agricultural export and population per square mile of agricultural land. The exports are chiefly cloves and copra.

Algeria, Tunis, and Morocco stand out as small grain lands and sub-tropical crop land and are also high in the production of animal units. The exports are chiefly small grains, wines, skins, beans, olives, dates, and eggs. Spanish Morocco produces chiefly eggs, hides, and skins.

The Union of South Africa and Basutoland could be placed with Algeria,

FIGURE 234.—Great fields of cotton are not regular in outline but extend for miles. Banana and many other plants are grown with the cotton. Nebumale, Uganda.

Tunis, and Morocco. The climatic conditions are much the same but the inhabitants distinctly different. South Africa is more of a "ranch country" (Figure 218). Its exports are chiefly wool, maize, hides, and skins. The inclusion of Natal makes this country far more varied than the North African group. Basutoland is fully developed as regards population and animal units, and is high in exports of wool, mohair, wheat, kaffir corn, and maize. In all probability this high rate of production of livestock is at the expense of the vegetation and soil resource. Swaziland should also be listed here. It exports cattle, tobacco, hides and cotton.

Nigeria stands out in the tropical group as a productive country from almost any point of view. With it in productive potentiality and type of production could be placed the Gold Coast, Ashanti, and Northern Territories, Sierra Leone, Dahomey, French Togoland, British Togoland, Liberia, Ivory Coast, French Guinea, Portuguese Guinea, and Gambia. Most of these are truly tropical but some of them run back to drier ground and to grazing lands. They produce therefore, along the coast and in the damper hotter parts, palm kernels and palm oil, cacao, cola nuts, copra, ginger, rubber, and coffee and in the back country, groundnuts, cotton, sesame, and hides and skins. Cabinet woods are important in some of these countries.

In the East African highlands (Figures 227, 230, 231, 233, 234, and 235), Kenya, Uganda, Urundi–Ruanda, Tanganyika, Nyasaland, and Ethiopia are similar in productivity and in the great variety of climate and surface offered for development. The chief exports are cotton, sisal, coffee, and hides and skins. Temperate and tropical crops can be grown which include cool-weather and hot-weather crops. Urundi–Ruanda is occupied by cattle raising (Figure 228), aristocratic native peoples, but the country is potentially capable of producing small grains, coffee, bananas, and almost any crop other than the strictly tropical. Tanganyika has more cotton and maize country than Kenya and Uganda but is less developed. It also has possibilities along the Indian Ocean for copra and other tropical crops. In Kenya, European agriculture is dominant and in this respect it differs from most of the countries considered in this group. Ethiopia, especially in the southwest in Kaffa, is potentially coffee and banana country. The highlands are ideal for small grains and the lower country for cotton and maize. To quite an extent this is also true of Kenya and Tanganyika. Nyasaland although much like the other countries here considered has been developed farther along the lines of the production of money crops. The highlands will produce small grains and the lowlands maize, sorghum, and cotton. But the chief exports, partly because of the transportation problem, are tobacco, tea, and cotton.

In the tropics the Kameroons British and French, Spanish Guinea, and Fernando Po, the Belgian Congo, and

FIGURE 235.—A plantation of Ceara rubber (*Manihot glaziovii*) which has reseeded into a thicket. A great area of this type of rubber was planted in Tanganyika. Moshi, Tanganyika.

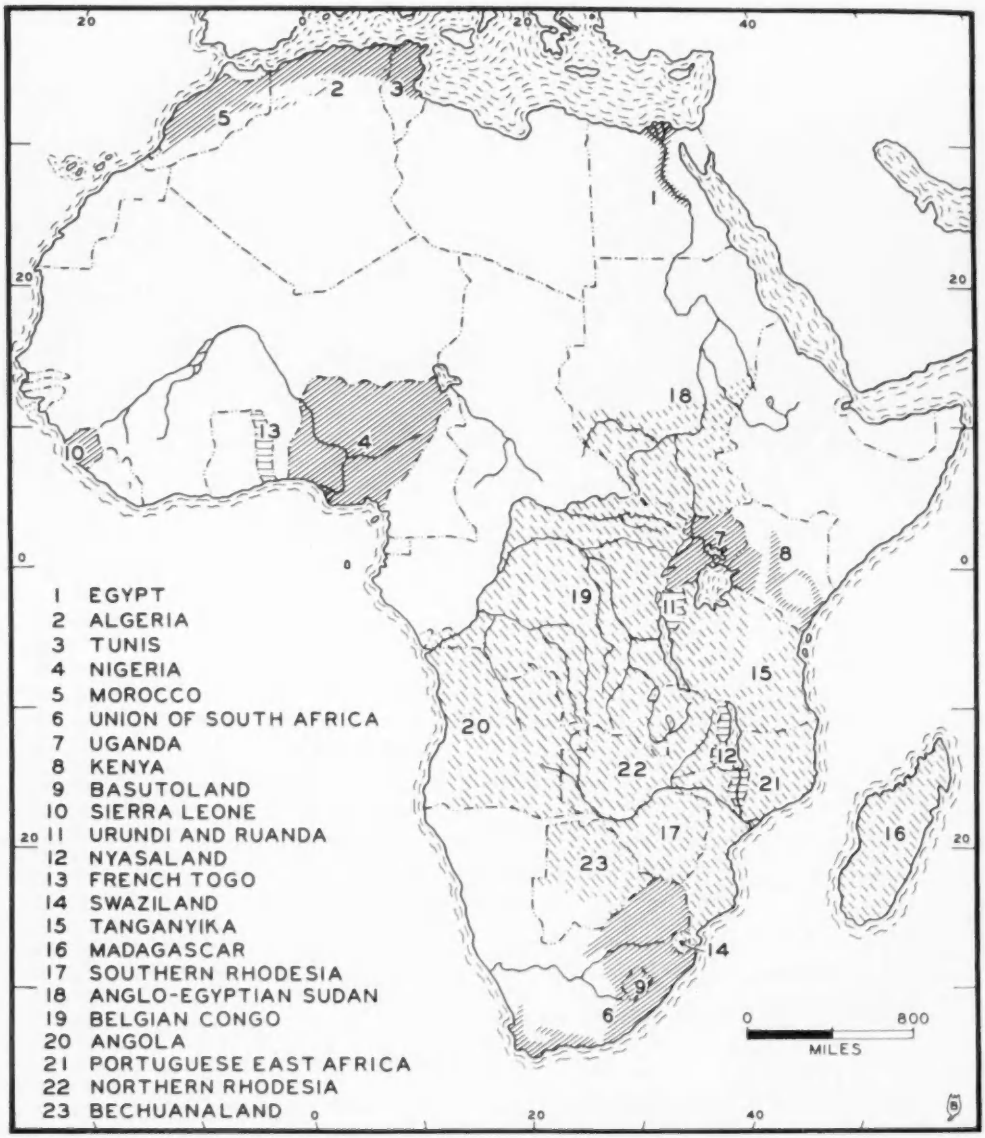

FIGURE 236.—The colonies listed in Table B, arranged on the basis of population and agricultural export per square mile of agricultural land. They are arranged in descending rank. The deepest shaded portion indicates the land most capable of crop production. The first ten are heavily shaded and the last ten lightly shaded. Numbers 11 to 13 are intermediate.

French Equatorial Africa are truly tropical except in the highlands. The Kameroon highlands are not markedly different from the East African highlands. But much of their export comes from the warmer part and is chiefly palm oil and kernels, cacao, and coffee. Spanish Guinea, and Fernando Po are also productive of palm oil and cacao. The Belgian Congo, although most of it lies in a great river basin at an elevation of over 1,000 feet (Figure 221), extends out beyond the tropical rain forest (Figure 237), in the north, east, south, and west, and while productive of palm nuts and oil, cacao, rubber, and coffee,

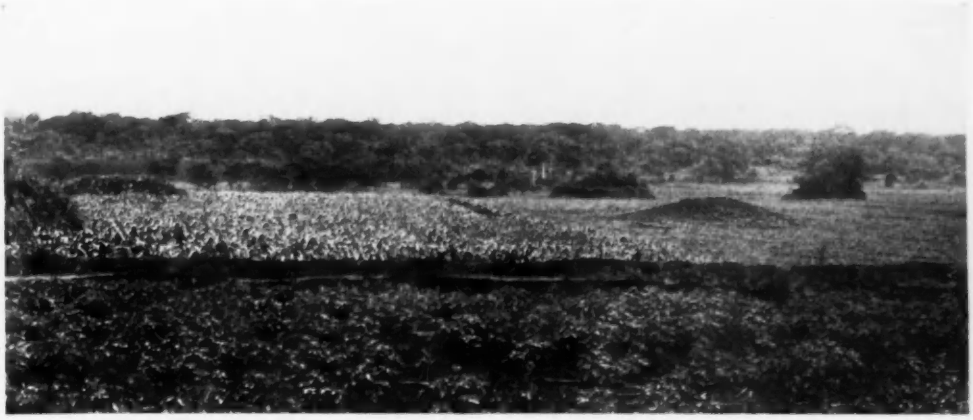

FIGURE 237.—Irish potatoes, maize, and sweet potatoes show the varied production possible. Termite hills and dry forests are shown in the background. Elizabethville, Belgian Congo.

also produces cotton, sesame, and skins. French Equatorial Africa extends from the central rain forest to the desert of the Sahara. It therefore contains all of the moisture and vegetation and crop belts which lie between these two extremes. It produces rubber, palm kernels, oil, cacao, and cabinet woods in the southern part and live domestic animals in the semi-desert areas. Senegal, French Sudan, Upper Volta, Niger Colony, French Equatorial Africa, and the Anglo-Egyptian Sudan are much alike in that they range from the high grass savanna to desert country and are divided sharply into a southern part which is potentially capable of crop production and a desert or semi-desert area suitable only to grazing. The exports are cotton, hides and skins, and groundnuts, but they also produce sorghums, shea butter, ivory, and rubber. Madagascar is productive of tropical crops, especially vanilla, coffee, peas, and manioc but exports largely hides and beef. Portuguese East Africa is potentially capable of producing much more than it does. Its chief exports are groundnuts, copra, sugar, and bananas but it also produces sorghums and maize in quantity. Angola and Northern Rhodesia are alike except that Angola extends farther into the tropics and produces palm oil and kernels, coffee and sugar, while Northern Rhodesia produces chiefly tobacco, hides and skins, maize, and on the highlands, wheat. Angola also produces maize, hides, and cotton. Southern Rhodesia

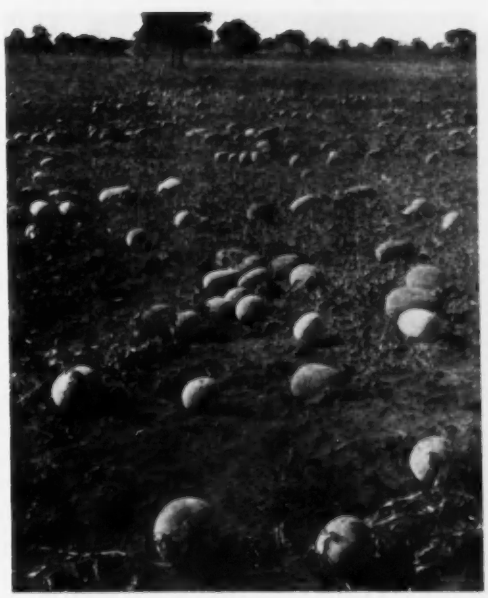

FIGURE 238.—A native melon, the m'tsama, a true wild watermelon, is not only an important stock melon but furnishes water for animals and man alike in regions where surface water is not available. It keeps well and can serve as food and drink during the long drought periods long after the annual vines of the plant are dead. Tjolotjo, Southern Rhodesia.

is largely European in its production which is tobacco, cattle, maize, hides (Figures 224 and 225) and a great variety of other produce (Figure 238). Bechuanaland is a semi-desert country and production is limited to cattle and cattle products (Figure 226). The Southwest African Mandate is much like Bechunanaland and is productive chiefly of cattle and sheep products such as skins, meat fresh and frozen, and hides and wool.

There remains a desert fringe of colonies of which Eritrea would rank first since it draws to some extent a water supply from the highlands of Ethiopia. It produces chiefly hides and skins, coffee, linseed, cotton, and camels. Tripolitania and Cyrenaica would rank next. Their exports are desert products such as skins, sheep and goats, dates, esparto, henna, and gee. Italian Somaliland produces hides and skins and cotton; British Somaliland skins, hides, and gee; Mauretania dried fish from the Atlantic Ocean, while French Somaliland, Rio de Oro, and Adrar and Ifni produce little or nothing.

COAL AND POLITICAL POWER IN EUROPE

Walter H. Voskuil

THE present conflict in Europe has brought sharply into relief the struggle among the powers for control of mineral resources. The goal of "Lebensraum," or the battle for control of the seas, is merely a phase of the conflict to achieve control over or possession of mineral resources, the essential materials of industrial production. In quick succession the Swedish iron ores, the ores of Lorraine, the Polish coal fields, the Rumanian oil fields, Yugoslavian bauxite, have passed across the stage for a brief moment of public attention, as the scene of the struggle shifted from one quarter to another. And beyond the boundaries of Europe, in remote quarters of the globe, lie the deposits of so-called strategic minerals for which each nation seeks mastery or access, to meet the needs of the highly developed metallurgical industries of today.

Among these minerals the European coal resources play a somewhat unobtrusive but exceedingly important part. In Europe, coal is the predominant source of energy. Petroleum and water power occupy secondary rôles.

Consumption of coal in western Europe (exclusive of Russia) and the United Kingdom, is approximately 650 million tons annually, whereas petroleum products contribute an equivalent energy of 75 million tons of coal, and water power contributes an estimated equivalent of 45 million tons. Western Europe consumes half of the coal output of the world. Of this consumption, by far the greater part is used in west central industrial Europe and the British Isles. The Mediterranean states take an additional but much smaller supply. The Baltic and Scandinavian lands take even less. Aside from that used in bunkering vessels, the overseas shipment of European coal is but a negligible part of the production and consumption in Europe itself. The market for European coal is in Europe.

Coal in the Present European War

Although much has been said about the vital importance of petroleum in the present struggle, and its significance must not be underrated, the rôle of coal is equally significant or even more so. Only a highly industrialized nation can wage a war on a large scale. Behind the front line equipment—the naval craft, the air force, tanks, power-drawn artillery, and motorized troop movements—is a large, heavily manned industrial plant and transportation system, and this requires for its operation far more fuel than the immediate instruments of warfare in the line of combat. Although the output of coal in the World War did not exceed greatly the level of an active peacetime period, there was nevertheless a considerable sacrifice of coal used for civilian and non-military needs. In the present war, production data are unobtainable but reports come from Germany of a coal shortage for domestic purposes and even in manufacturing plants. Coal bears the same relationship to oil that the back of a knife does to the cutting edge. Oil, in tanks, airplanes, boats, draws through the enemy lines like the sharp edge of a knife; coal, as industrial and locomotive fuel, by supplying the materials of war, gives firmness and strength to the cutting edge.

Apart from its industrial significance,

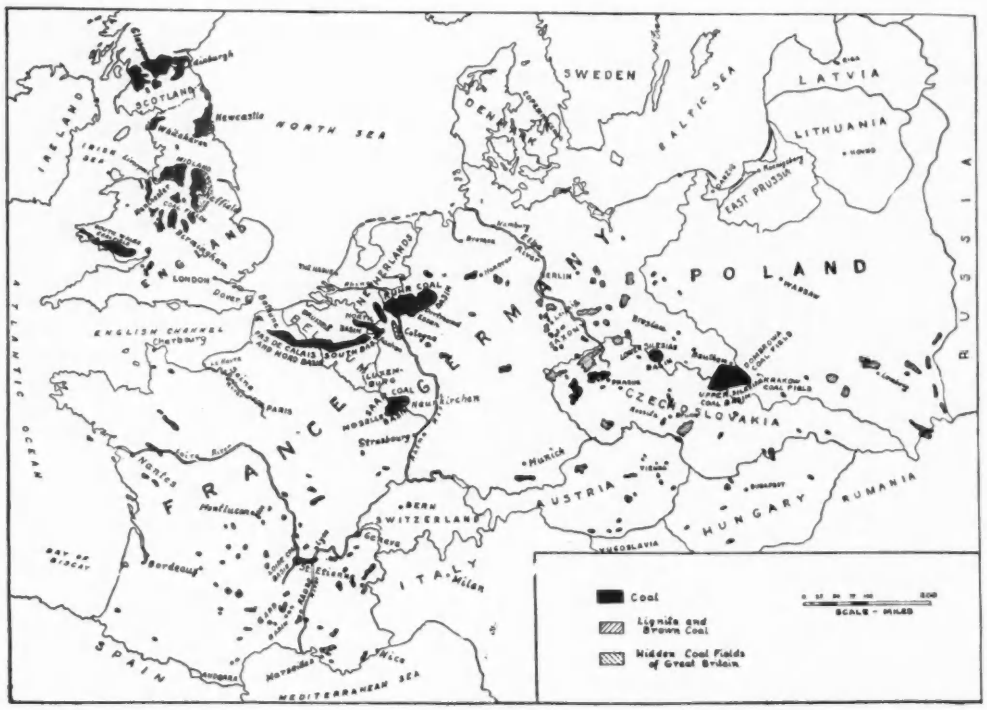

FIGURE 1.—Three coal mining areas—in Great Britain, the Ruhr district, and the Upper Silesian district in occupied Poland—supply the coal needs of the nations of western Europe. Previous to the outbreak of the war, the Scandinavian nations were supplied mainly by Britain and Poland; Germany and Britain shared the markets in the low countries, France and Italy; while the Ruhr and Silesian districts dominated in central and southeastern Europe. (From U. S. Bureau of Mines, Bull. 414, "Coal Mining in Europe," by George S. Rice and Irving Hartmann, 1939.)

coal plays an important rôle in the present war as an instrument of political power. Possession of coal resources holds the key to industrial development, in some cases even food supply, in those nations not so favored. When possession of coal is exclusively in the hands of one nation, the power over neutral as well as subject states is great.

Control by governments of the coal industry is largely a post-World War development. Political control, intervention, or assistance, accounted for significant developments in the coal industry during this period. It is likely to be of even greater significance during this war and after.

In order to comprehend more fully the significance of coal in the future development of Europe, a brief review of events leading up to the present status is essential. We begin with a brief survey of the coal fields of Europe.

COAL FIELDS OF WESTERN EUROPE

The coal map of western Europe shows three areas of major and exportable production—the coal fields of the United Kingdom; those of western Germany with outliers into Belgium, the Netherlands, and northern France; and the Upper Silesian and Dumbrova fields of vanquished Poland in the eastern limits of western Europe (Figure 1). The coal output of the U.S.S.R., though third largest in Europe, is used mainly in home consumption and is not of significant importance in international relations. In an estimate published by the Reichskohlenrat report for 1938, it

TABLE I

COAL RESERVES OF EUROPE*

(In millions of metric tons)

Country	Bituminous Coal		Brown Coal	
	Proven and Probable	*Proven*	*Proven and Probable*	*Proven*
United Kingdom	200,161	138,183	.....	.....
Central and Western Europe:				
Germany	106,373	59,451	56,578	28,837
Poland	138,128	9,600	17,326	973
Czechoslovakia	28,410	2,266	12,393	3,097
Belgium	11,000	.....	.....	.....
France	10,000	595	500	80
Netherlands	4,402	585	5	.....
Hungary	220	3	1,000	176
Austria	4	4	525	525
Scandinavia:				
Denmark	.....	.....	50	.....
Sweden	114	106	.....	.....
Spitzbergen	8,750	.....	.....	.....
Mediterranean States:				
Spain	8,001	5,826	767	394
Bulgaria	140	30	3,860	358
Italy	120	3	290	49
Yugoslavia	45	4	4,679	2,088
Romania	31	7	2,839	717
Greece	.....	.....	40	10
U.S.S.R.	98,635	13,196	15,299	518

*Statistische Übersicht über die Kohlenwirtschaft im Jahre 1938, Reichskohlenrat, Berlin W. 15, Pariser Strasze 44.

is noted that Germany has the largest estimated "known and probable" resources of any country in Europe, if its brown coal resources are included.

However, German raw brown coal has about one-quarter of the thermal efficiency of high-rank bituminous coal, which has made that district—in proximity to the Lorraine iron deposits—the most important producer of iron and steel on the continent.

Great Britain is a close second to Germany in total "known and probable" coal resources and it has larger "known" coal deposits than any country in Europe. In South Wales occur the only true anthracite fields of note in Europe.

Poland has large resources of bituminous coal in the Upper Silesian Basin. European Russia has the next largest coal resources of any country in Europe. France, Belgium, and Czechoslovakia, which are next in importance, have relatively small resources, but these are highly important in local steel making.

Due to the military advances into the regions lying to the west, Greater Germany has assumed a position of dominance in the European coal industry which was already foreshadowed through the conquest of Poland in 1938. Belgium, the Netherlands, northern France, are in German hands. There are no coal lands of importance left on Continental Europe in the hands of free nations.

Opposed to the German coal power on the continent are the coal resources of the United Kingdom. The struggle is between these two powers and the stakes are large. The economic control of industry in Europe is in the balance. In order to understand the significant rôle that coal plays in this struggle, it will be necessary to review the industry briefly from the period of 1913, and to

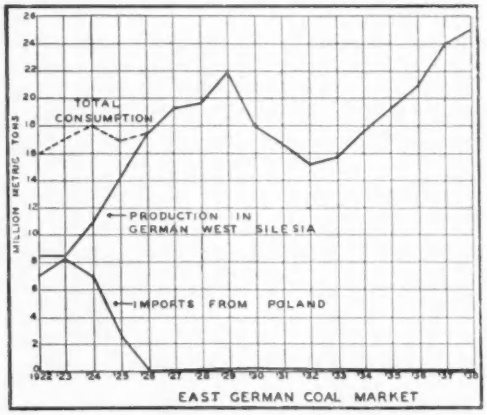
MILLION METRIC TONS
TOTAL CONSUMPTION
PRODUCTION IN GERMAN WEST SILESIA
IMPORTS FROM POLAND
1922 '23 '24 '25 '26 '27 '28 '29 '30 '31 '32 '33 '34 '35 '36 '37 '38
EAST GERMAN COAL MARKET

FIGURE 2.—The creation of a Polish nation after the World War brought about its repercussions in the coal industry of the Silesian district. By 1926 the East Upper Silesian district in Poland had lost its coal markets in eastern Germany to the new mining developments in German West Silesia. Only the occurrence of a prolonged strike among British coal miners in 1926 relieved a threatened idleness in the mines by opening the Scandinavian coal market to the Polish industry.

follow its changes up to and into the present struggle.

COAL IN 1913

During the years from 1870 to the outbreak of the World War in 1914, the coal-mining industry had a rapid growth in many countries. The development of iron and steel manufacturing, the expansion of railway systems, the increasing use of electric power and of manufactured gas for industrial and domestic purposes, the great growth of population in Europe and the Americas—in brief, all the factors which made for the expansion of the industrial system and for the growth of world economy—acted to increase the demand for coal and to enhance the importance of coal in the industrial economy.

In this pre-war Europe, the intra-European movements of coal were relatively unimpeded by tariff restrictions or undue stimulation by special privileges or concessions.

The growing demand of many countries for coal led to a large increase in coal exports from both the coal-surplus countries of Great Britain and Germany, with Britain the leading exporting country. The latter nation sent its coal to sixty nations or colonies in four continents. British coal also supplied the bunker fuels for the commercial fleets of European nations.

British and German coal exports in Europe were largely complementary. The former supplied mainly the Mediterranean and Baltic states, Italy, Spain, and also Baltic Russia, Denmark, Norway, and Sweden. Germany had an exclusive market in the old Austro-Hungarian Empire, and in Switzerland. Only in France, Belgium, and the Netherlands did these two coal producing nations compete. Notwithstanding its large coal exports, Germany imported considerable quantities from England, France, and the Netherlands, mainly for special purposes.

COAL IN THE POST-WAR YEARS

The exigencies of the World War and the peace treaties that followed produced profound disturbances in the coal industry of Europe and to some extent in the world coal trade as well.

Five major factors that were concerned in substantially modifying the pre-war structure of the European coal industry were:

1. The changes in national boundaries affected by the peace treaties.
2. The effect of coal and coke reparations requirements.
3. Rise of competitive fuels.
4. Expansion of coal mine capacity in response to a drive toward economic self-sufficiency among the several nations.
5. The increase of government participation in the conduct of the coal industry.

The East Upper Silesian coal field of Germany and the Dumbrova coal

field of Russia were included in the newly created state of Poland, the Saar was removed from German jurisdiction until 1935, Alsace-Lorraine was transferred to France, and Luxembourg was included in the Belgian customs union.

Post-war changes brought about a severe decline in the British export trade in Europe, a sharp rise in German production and exports, the entry of the Polish East Upper Silesian coal field in the European markets, and a decline of coal consumption in the bunker trade.

Probably the most significant change in the structure of the coal industry resulted from the change in boundary between Germany and Poland in the Silesian district. Before the war, the Upper Silesian coal fields in German territory, and these fields, together supplied the bulk of the coal needs in the eastern districts of Germany with some export to Russian Poland. In the post-war readjustments, the East Upper Silesian field was awarded to Poland, with its annual output of 30 million tons or over. This transfer, in 1922, left eastern Germany without adequate local coal supplies, whereas Poland controlled a productive capacity in excess of its own needs. Under an agreement of three years' duration, and terminating in June 1925, Germany agreed to take coal from Poland at a rate of 6 million tons a year. Shipments during 1923 and 1924, however, exceeded this amount, the actual quantities delivered being 8.4 and 7.0 million, respectively. In the meantime, Germany increased its productive capacity in the West Upper Silesian field to compensate its losses in the eastern field. At the expiration of the agreement in June 1925, production in Germany's own field had so expanded as to take care of the local domestic needs and the imports from Poland practically ceased. The trend of coal shipments

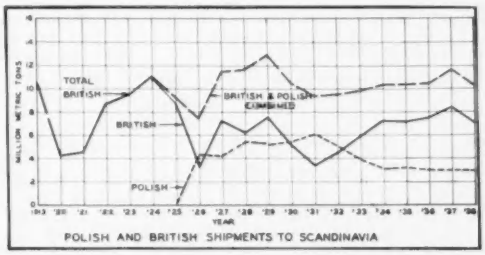

FIGURE 3.—The shift from British to Polish coal, beginning in the later months of 1925, is portrayed in this graph. With the exception of the depression years of 1920 and 1921, consumption of coal in the Scandinavian nations remained relatively constant. British coal industry recovered part of its lost markets after an agreement had been reached with the Scandinavian nations on allocation of tonnages between the two coal producing nations.

from 1922 to 1936 is shown in Figure 2. The net effect of this development was to expand the productive capacity of the entire Silesian area. With surplus mine capacity available, the Polish producers, deprived of their usual market, were compelled to seek outlets elsewhere. The prolonged strike of the British miners in 1926 opened the way for entry of Polish coal into the Scandinavian market. Exports to these countries from Poland increased from 0.5 million tons in 1925 to 5.4 million tons in 1928, and remained above 5.0 million tons through 1932. The history of this movement to the Scandinavian market is illustrated in Figure 3.

The British finally succeeded, in 1933, in securing a degree of stability in the Scandinavian markets through agreements whereby Sweden imported 47 per cent of its annual requirements from the United Kingdom and Norway took 70 per cent of hers.

Second in importance to the rise of the Silesian Polish coal industry as a factor in continental trade were the German reparations shipments to France, Belgium, and Italy. The demand for reparations coal and coke was occasioned by the acute fuel shortage in these countries and the need for fuel to bring

about a rehabilitation of industry. With the exception of 1923, German post-war exports to France exceeded the 1913 level while exports to Belgium showed a slight decline. The most important change, however, was in the Italian market. The effect of German shipments, reparations and otherwise, upon British shipments to this market, is apparent from this comparison (Figure 4).

A third factor affecting the European coal industry in the post-war period was the development or expansion of coal mining in smaller nations. This was particularly the case of the Netherlands, whose output rose from 2 million tons in 1933 to 14 million tons in 1937. Substantial but less spectacular increases were recorded in Belgium and France. In Germany itself, there were phenomenal increases in brown coal production to offset in part the loss of Upper Silesia and the Saar.

Finally, the decline in world shipping and the rising competition of oil-driven vessels accentuated the decline in bunker coal use. Since 1914, marine engineering has tended strongly away from the coal-fired vessel in favor of ships either oil-fired or operated by Diesel motors burning oil. Coal-fired vessels fell in tonnage between 1914 and 1937 from 44 million, or 97 per cent of the world total, to 32 million, or 49 per cent. The British bunker coal trades, most severely affected of all coal producers, fell from 21 million tons to 12 million tons in the same period.

The post-war expansion of coal mine capacity, partly a response to temporary exigencies not related to long requirements of the market, and also due to a drive for economic self-sufficiency, did not permit the competitive advantages and disadvantages due to ease of mining, closeness to markets, skill of labor, etc., to exercise free play in shaping the structure of the European coal industry. Practically all European governments have applied special measures to regulate competition on the home market, to swing the balance of competition abroad in favor of their own nationals, to enter into preferential trading arrangements as exporters or importers of coal. A brief account of these measures will help to clarify the processes by which the strictly economic factors of international competition have been blocked from full expression in the coal markets of the world.

Customs duties.—This included not only tariff levies in the strict sense, but also many kinds of special import levies including turnover, excises and equalization taxes, port, river, and primage charges, as well as fees for import licenses where quota systems are in force.

Quota systems.—Quota systems were put into effect for the protection of the national collieries against foreign competition. In certain cases, also, the purpose has been to foster the consumption of peat or firewood, or both.

Export subsidies.—Direct or indirect subsidies in aid of the coal export trade are an almost universal practice; by means of such subsidies, the countries which struggle for world markets seek to gain marketing advantages for their national collieries or to relieve them from marketing disadvantages. Direct or indirect, official or quasi-official, the practice of allowing subsidies to the coal export trade assumed a great variety of forms, of which four types may be usefully distinguished:

(1) Export shipments may be aided by special bonus or premium payments, in which event the necessary sums are usually raised by levies upon the output of coal, or upon the tonnage consumed by the home markets;

(2) Freight charge schedules, usually those of State railways, may be adjusted

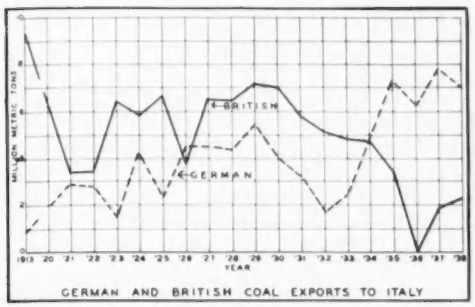
MILLION METRIC TONS
BRITISH
GERMAN
1913 '20 '21 '22 '23 '24 '25 '26 '27 '28 '29 '30 '31 '32 '33 '34 '35 '36 '37 '38
YEAR
GERMAN AND BRITISH COAL EXPORTS TO ITALY

FIGURE 4.—Gradual displacement of British by German coal in the Italian market is partly in consequence of the coal and coke provisions of the Treaty of Versailles and partly the result of continued closer economic collaboration between Germany and Italy.

so as to encourage export shipments, discourage import shipments, or both. The best known example would be the exceptionally low charges for hauling coal by rail from Katowice in East Upper Silesia to Gdynia or Danzig on the Baltic. Several nations, besides Poland, engaged in similar practices. To the extent that railways must recoup these allowances by higher freight rates on other commodities, it is the home market consumer who pays.

(3) Collieries may be granted special facilities in the way of relief from tax burdens, particularly in regard to export shipments of coal. The outstanding example of favoring a national coal industry by relief from tax burdens is afforded by the Derating Scheme in England which came into effect in 1929.

(4) The coal trade may be organized commercially so as to facilitate exports at lower prices than prevail for the same kinds and grades of coal in the home market.

Preferential trade agreements.—One of the outstanding commercial characteristics of the period since 1929 has been the tendency to replace multi-lateral by bilateral trading. Until the outbreak of the present war, the European coal markets as a whole were characterized by a multitude of preferential trade agreements and barter agreements; it would be hard indeed to find a single market of any consequence where preferential advantages were not granted to one supplier or one group of supplies.

ECONOMIC CONSEQUENCES OF EUROPEAN COAL POLICY

In attempting to evaluate the economic consequences of Europe's post-World War coal policies, it is necessary to examine briefly the relation of Europe's physical resources to the political aspects of the continent.

The continent of Europe, itself, is abundantly endowed with the mineral resources necessary for as high a degree of material prosperity as modern technology can provide. The coal fields of Britain, Germany, and Poland, and the iron ores of France, Great Britain, Sweden, Spain, and North Africa provide the basic raw materials of industrial society. Supporting these basic materials are the extensive oil resources of the Near East (which is geographically and politically associated with Europe); lead and zinc in Silesia and Spain; aluminum ores in France, Norway, Dalmatia, and Hungary; potash in Germany; phosphates in North Africa; and pyrites in Spain. There are deficiencies it is true, but, under a condition of free access to the ocean, these deficiencies are not serious.

Imposed upon this abundantly endowed physical area are a number of political units, not one of which possesses ample raw materials or unified market outlets for the economical and effective operation of a productive society based upon power machinery, mass production, and a mass market. Nor has European statesmanship been able to achieve the political unity or international coöperation necessary for the construction of an efficient economic unit. In varying degrees and in several forms the struggle for an economy based

upon national self-sufficiency was not only continued after the World War, it was intensified.

Instead of coöperation, Europe chose narrow nationalism. Germany turned to synthetic liquid fuel from coal, iron from low-grade ores, aluminum for copper, synthetic rubber, for "ersatz" materials. Poland subsidized a coal export industry for foreign credits and taxed the domestic users to provide for this luxury; France drained her wealth into the Maginot Line and ultimate downfall; England tried to shut out the continent by Empire trading; all ignored the fact of the fundamental economic unity of the European continent and the economic interdependence of European political subdivisions.

In this intense nationalistic competition, the several nations turned to whatever economic weapons were at their command, of which coal was an important one. Instead of an instrumentality for achieving continental prosperity, coal was used as a weapon for the achievement of national superiority. The development of excess mine capacity in Europe served to divert unduly labor effort and capital investment into mine equipment, and attempted coal production—efforts which, in an efficiently managed economy, should have been directed toward the production of goods and services really needed in Europe.

THE PRESENT WAR

The outbreak of the present war has swept away many preëxisting arrangements and decidedly altered the trade channels of pre-war coal trade. In quick succession, the coal industries of Czechoslovakia, Poland, the Netherlands, Belgium, and northern France fell into the hands of the German conquerors. The coal resources of western Europe are now controlled by two powers: the British and the German.

British coal, normally supplying the largest portion of the coal needs of the Baltic states, was barred from the Baltic Sea by the German blockade, and to these states was left no other alternative but to depend upon the coal reserve of Germany and Polish Silesia. Here the problem of coal supply for these nations was synonymous with the problem of coal transportation in Germany. It is reported that one condition under which Germany agreed to increase coal shipments to Lithuania in order to meet the added demand resulting from the cessation of British shipments, has been that Lithuania supply rolling stock.

The Scandinavian countries are in a similar position with respect to coal supply except that the tonnages involved are far greater than in the Baltic states. In spite of extensive water-power developments and also the use of wood as a fuel, the Scandinavian nation imported each year approximately 16 million tons of coal and coke. For decades they have depended almost entirely upon Great Britain for a coal supply, and only since 1925 has Poland, and more recently Germany, encroached upon this market. The position of Sweden, by reason of its land-locked position, became critical with the invasion of Poland and the German blockade of the Kattegat. The index of coal prices (1913 = 100) rose from 128 in January 1939, to 134 in August, 191 in September, 202 in October, 208 in November, and 239 in December, as against 125 in December 1938.

The invasion of Norway in April 1940, extended and intensified an already critical condition with respect to fuel supplies. Occupation of Danish and Norwegian ports by the Germans, the last connection of the Scandinavian nations with their customary sources of coal supply, leave open to them only

as much as the Germans are able and willing to supply.

THE POSITION OF ITALY

Because of British command of the high seas, German exports of coal to Italy have had to turn from the cheap and convenient sea route through the port of Rotterdam to the more costly trans-Alpine route. On the occasion of the Reich's Foreign Minister's visit to Rome on March 12, 1940, it was agreed that Italy's entire coal needs were to be covered in Germany and would, in future, be transported by land. This supply, in spite of the burden imposed upon the German railway system, has, according to reports, been maintained. (*Notes on the German Coal Trades*. Required report No. 1530, by William L. Sayser, Third Secretary and Vice Consul, American Embassy, Berlin, Germany, June 8, 1940.) With the conquest of France, it was hoped that some relief might be obtained by the utilization of French mines and railway equipment. The results do not appear to rise to expectations, for unoccupied France is suffering from a coal shortage.

British coal industry, in the meantime, is suffering a loss of markets, and unemployment. Deprived of the continental European market, with one or two minor exceptions, this represents a loss of approximately 25 to 28 million tons of coal, or ten per cent of the national output.

ULTIMATE EFFECTS

The coal control measure and the dislocation of the coal trade as affected by the war are of less significance than the ultimate effects of the disappearance of a free economy in the coal industry and the substitution therefor of political control. To speculate upon the future political and international events in Europe is a project too venturesome to be undertaken here. Discussion will be restricted to an attempted prognosis of the consequences of German hegemony over continental Europe. The reality will probably shape many things quite differently. The Axis powers, under German leadership, have attained such hegemony over continental Europe, including a control over the coal producing districts. With a monopolistic control of this key resource, domination over the continental European economy, including the economy of the present independent states of Sweden, Finland, Switzerland, and possibly Spain, is complete.

Control of coal resources and markets of western Europe will immediately increase Germany's bargaining power with neighboring states. Through the medium of bilateral agreements or barter arrangements, the rates of exchange between two countries will depend upon the relative bargaining power of each. The prime necessity of coal by all European nations places Germany in the superior position.

That the Germans will take every advantage of the bargaining power inherent in their possession of coal is shown by the treatment accorded the Scandinavian nations. In these nations, the Germans are exploiting their military and political predominance to bring about increases in prices of German goods while decreasing or maintaining at the same levels the prices of other countries. While the Swedish nation has, by reason of its monopoly over wood and pulp, withstood the demanded increases in prices of coal and coke, Denmark and Norway have not been so fortunate. These latter nations are paying 80 per cent more than Sweden for German coal simply because there the Germans are the real masters.

Control over dependent and neighbor

states does not, moreover, limit itself to favorable trade agreements. The existence of industry itself would be subject to the will of the coal masters. Suggestions, purported to come from German sources, that industries in conquered or dependent nations would be reduced in scope, or discontinued, and manufacturing industries concentrated in Germany, lend color to the possibility that re-location of industry would be effected. France and Italy would be especially affected, but even the Balkans would witness industrial readjustments.

In France, coal supplies were inadequate for her industrial, railroad and other needs. She imported large tonnages of coal and coke from Germany, the United Kingdom, Belgium, and the Netherlands. Altogether, imports of French coal and coke are equal to 60 per cent of domestic production. France, because of its large iron ore supply, is singularly dependent upon Germany. French economy required sources of coke and coking coal to support the iron and steel industry for which she exchanged large quantities of iron ore mainly to Germany, Belgium, and Luxembourg. The future of French industry, in the event of continued German hegemony on the continent, is intimately related to German policy.

The case of Italy represents a nation almost completely dependent upon the outside world for industrial raw materials. Of such basic industrial materials as coal, iron, copper ore, petroleum, lead and zinc, Italy has practically none. Coal consumption is in the neighborhood of 14 million tons yearly. In 1913, England supplied 90 per cent. By 1937, Germany had risen to 60 per cent and Great Britain had fallen to 16 per cent. Poland, Belgium, and Czechoslovakia (now under German control), supplied the rest. Deprived of British coal sources, Italy has become for the time being utterly dependent upon Germany.

EFFECT OF A CLOSED CONTINENTAL ECONOMY ON GREAT BRITAIN

Coal is the keystone in the British economic structure. The industry provides employment for more men than any other in Britain, with the exception of agriculture. It is the basis of the iron and steel, shipbuilding and engineering trades.

British coal exports have an economic importance greater than might be supposed after noting that only one-fifth of the production is exported. British imports consist largely of raw materials for industry and of vitally necessary foodstuffs. Exports of finished manufactured goods are not bulky, and the difference is made up by coal. Thus coal is practically always available for a return cargo and greatly reduces freight rates by providing a balanced and efficient two-way traffic. Coal exports have made possible the sale of British manufactured goods in many regions where they might not otherwise have penetrated without low freight rates.

BRITISH COAL EXPORTS

	Millions of Tons		*Decrease, per cent*
	1931	*1937*	
British exports to Europe	60.1	32.9	54.7
British bunker shipments	21.4	11.9	55.6
Total	81.5	44.8	55.0

Britain's best coal market has been continental Europe; specifically, France, Italy, Germany, Belgium, the Netherlands, and Scandinavia. Second to the European coal market is the bunker trade. The immediate consequence of the post-war developments in the conti-

nental coal industry was a severe decline in the British overseas trade. A comparison of 1913 and 1937 tells the story.

The production of coal on the continent rose from 42.5 per cent of western European production in 1913, to 50.7 per cent in 1938. Thus at the eve of the outbreak of the European war, Britain's coal industry was facing difficult problems of continental competition that held the prosperity of that industry in the balance. For every Briton, the question of what the future held forth was and is exceedingly important. The coal question as it affects Great Britain was carefully reviewed by E. O. Foerster-Brown, and his conclusions are none too hopeful. He points out that, although British reserves are so large that exhaustion would not appear for many hundreds of years at the present rate of production, the continuance of a coal industry depends ultimately upon whether the home or foreign consumer can afford to pay the prices necessary to sustain a mining industry. Apart from external charges over which the operator has no control, the fundamental factors are the cost of production, and the quality of the coal produced. For Great Britain the crux of the problem is really the comparative costs of production and quality of coal with that of the Rhenish-Westphalian field of western Germany. "Put shortly, other conditions being equal, is the cost of supplying coal to consumers from the remaining reserves of coal in Great Britain at the current rate of output likely to increase more, or less, rapidly than the cost of supplying consumers at the current rate of output from the coal reserves in other important coal producing countries? Further, how will the quality of the remaining reserves of coal compare? Upon the answers to these two questions . . . depends any estimate of the length of the period for which Great Britain can hold her position as a great industrial power, and support anything approaching the existing level of population." (Foerster-Brown, E. O., "The Coal Question," Presidential address given before the British Institute of Mining Engineers, Sheffield, England, Feb. 10, 1940, published in the *Colliery Guardian*, No. 4129, Vol. CLX, London, pp. 251–3, Feb. 16, 1941.)

Based upon a wide experience in examination and evaluation of mine properties and coal reserves in both England and Germany, Mr. Foerster-Brown comes to the conclusion that the average life of British collieries will be from 45 to 75 years, depending upon the extent to which the seams are worked; whereas the average life of the German collieries at the current rates of output was estimated at 185 years. Estimates for British industry were based on examination of collieries accounting for 25 per cent of the national production; in Germany, on a considerably smaller percentage.

From an exhaustive analysis of the position of coal in the British economy, Mr. Foerster-Brown comes to the conclusion, first, that a large output of coal is essential to employ and support the existing level of population; secondly, that Great Britain is more dependent for her prosperity upon a high absorption of coal for export and industrial purposes than other important coal producing countries; and thirdly, that the foregoing conditions can be maintained only if the effects of increasing natural difficulties and the exhaustion of the better quality seams in British coal fields can be neutralized by keeping the cost of supplying coal to consumers down to the lowest practical level in comparison with other coal exporting or industrial countries.

If Foerster-Brown's conclusions, in this respect, are correct, then it would appear that a German continental victory, followed by a policy of exclusion of British coal, will impose upon Britain problems far greater than those raised by E. O. Foerster-Brown in his address. Heroic measures would be attempted, would be necessary, in fact, to preserve the British position; but in the light of the keenness of the competitive struggle under pre-war conditions, such a substantial curtailment as is suggested in the events across the sea today would be a most serious challenge to British existence.

THE MICHIGAN LIMESTONE INDUSTRY

Paul Cross Morrison

RECENT world events have caused great interest in facts of production of minerals in which the United States is deficient but which it finds indispensable to national welfare. Much has also been written concerning production of important minerals in which no deficiency exists. Consequently, it is strange that but little study has been devoted to the production of limestone in the United States, for limestone is a basic raw material, essential directly or indirectly to a greater number of industries than any metallic or other nonmetallic mineral substance.

A recent publication by the Illinois Geological Survey (Rept. of Investigations, No. 49, 1938) discusses specifications for more than fifty direct uses of limestone. As lime, limestone has a wide chemical use, there being almost no chemical process wherein lime is not used in some stage, either directly or in the manufacture of the reagents. As stone, or as lime, great tonnages of limestone are used for building, railroad ballast, road metal, concrete aggregate, and the manufacture of iron and steel, cement, alkali, calcium carbide, paper, glass, sugar, leather, and many other products.

Among all products of mines and quarries of this country, limestone is normally exceeded only by bituminous coal, and in some years by sand and gravel, in the annual tonnage produced. Indicative of the low per unit production costs, however, are the usually greater values of the petroleum, bituminous coal, lead, natural gas, iron ore, copper, anthracite coal, and gold produced. National production of limestone in 1937 totalled some 132,374,270 short tons, valued at about $126,053,087.

Position of Michigan in the Limestone Industry

Statistics for 1937 are largely used because they were thought to be more nearly representative of a normal condition in the stone industry than later statistics. They picture the industry just prior to serious hostilities in Europe and launching of the National Defense Program in the United States. Most statistics are from (1) *Minerals Yearbook*, U. S. Bur. of Mines; (2) *Mineral Resources of Michigan*, Michigan Geol. and Biol. Survey; (3) *United States Census Reports;* and (4) *Annual Report of Chief of Engineers*, United States Army.

Michigan usually ranks second only to Pennsylvania as a producer of limestone. Output in 1937 for all uses was 15,445,211 short tons, valued at $7,627,970—approximately 11 per cent of the national tonnage and 6 per cent of the national value of this product. Other leading producing states are Ohio, Illinois, and New York (Table I).

Michigan limestone is largely produced for five uses. In 1937 almost half the stone, 45.8 per cent, was flux stone for the iron and steel industry. Following was stone for alkali manufacture, 19.6 per cent; for cement making, 19.0 per cent; for concrete and road building, 7.7 per cent; for lime burning, 2.8 per cent. Stone for these five uses totalled 95 per cent of the production.

In production for three of these five uses, Michigan has a high national ranking. Michigan has long been the leading source of stone for alkali manu-

TABLE 1

LIMESTONE

ESTIMATED PRODUCTION, 1937, FOR ALL USES IN LEADING STATES[1]

(Short Tons)

Use	*Pennsylvania*	*Michigan*	*Ohio*	*Illinois*	*New York*
Crushed Stone	12,713,830	12,103,970	9,891,860	9,801,470	8,802,050
Dimension Stone	15,710	Small	27,070	18,260	Small
Lime[2]	1,385,870	436,285	2,138,750	284,245	111,895
Portland Cement[2]	5,913,965	2,904,955	1,461,460	1,345,155	1,174,770
Total	20,029,375	15,445,210	13,519,140	11,449,130	10,088,715

[1] Sources—*Minerals Yearbook*, 1938, Bur. Mines, U. S. Dept. Interior, 1938; and Michigan Dept. Conservation, Geol. Survey Division.

[2] Except for Michigan, tonnages were obtained by conversion of barrels of cement and tons of lime produced, at the estimated yield of 3.9 barrels of cement and 0.5 tons of lime per ton of limestone. Allowance was made in New York statistics for 341,325 tons of limestone shipped in from Michigan for use in the manufacture of cement, but no allowance was made for certain amounts of stone shipped from Michigan to one Ohio cement plant, and to lime producers in New York and Illinois.

facture, and since 1917 has held a position second only to Pennsylvania in the production of flux stone. Michigan quarries in 1937 accounted for 62.4 per cent of the alkali stone and 33.2 per cent of the flux stone produced in the United States. The same year Michigan was exceeded only by Pennsylvania, and possibly California, in the production of limestone used in the cement industry, providing about 9.5 per cent of this stone. In addition, Michigan usually furnishes most of the limestone used by calcium carbide plants and significant percentages of that used by paper mills and sugar refineries.

Usually limestone exceeds in tonnage, though not in value, the output of any other Michigan mineral or mineral product. Some 1,500 Michigan workers and their dependents rely directly upon the quarries for their livelihood, not to mention other hundreds indirectly dependent upon the quarry operations. The quarries often provide the main, and in one or two cases the only source, of industrial employment in their locality.

PERIPHERAL LOCATION OF THE LIMESTONE RESOURCE

The western half of the Northern Peninsula of Michigan is largely underlain by Archeozoic and Proterozoic rocks. These are mostly volcanics and metamorphics. Paleozoic rocks underly the eastern half of the Northern Peninsula and the entire Southern Peninsula. These form a structural basin (the Michigan Basin). Since most of the limestone formations are in the lower part of the stratigraphic column present in this basin, their outcrops are near the margins of the state. Much of the eastern half of the Northern Peninsula is underlain by limestone beds, while an important belt of limestone extends around the northern end of the Southern Peninsula and another borders Lake Erie in the southeast (Figure 1). For a description of the different limestone formations see R. A. Smith: The Limestones of Michigan, *Mineral Resources of Michigan, 1915*, Michigan Geol. and Biol. Survey Pub. 21, Geol. Ser. 17, 1916, pp. 101–311.

HISTORICAL SUMMARY

Early development of the Michigan limestone industry was largely in the southern part of the Southern Peninsula, with a secondary development at the eastern end of the Northern Peninsula. Previous to 1749, shortly after the arrival of the first white settlers, quarries were worked near Detroit at the site of the present Sibley quarry and on Stoney Island. By 1839, limestone had been quarried at some fifteen places in Monroe County and four in Wayne County; also at Bellevue in Eaton County, Grand Rapids in Kent County, north of Jackson in Jackson County, and at several places on the islands and mainland at the eastern end of the Northern Peninsula.

Early use of the quarry product was

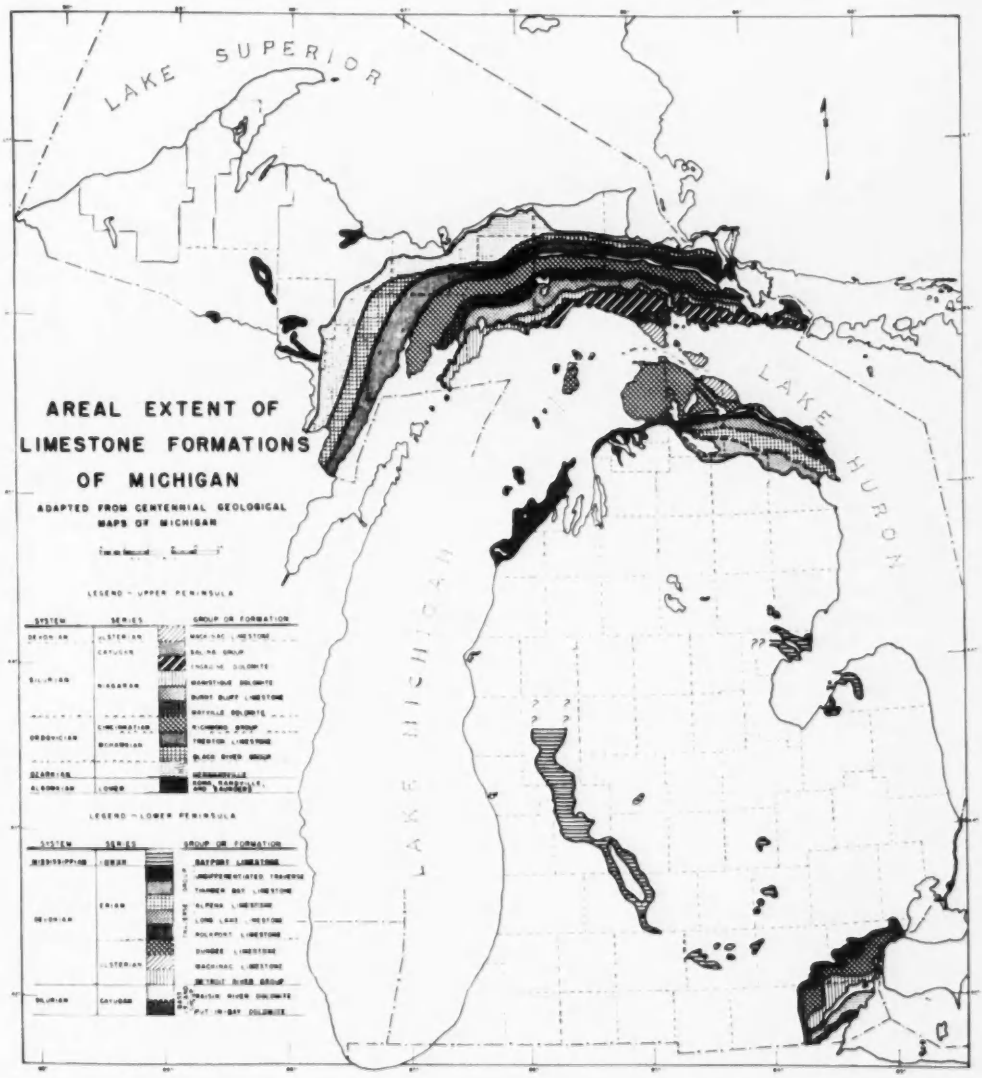

FIGURE 1.—Michigan quarry development has been largely in the extensive deposits of high calcium limestone, but the state is also fortunate in having vast deposits of high quality dolomite. The latter, especially the Engadine dolomite in the Northern Peninsula, give promise of soon becoming an important source of raw material for the production of metallic magnesium.

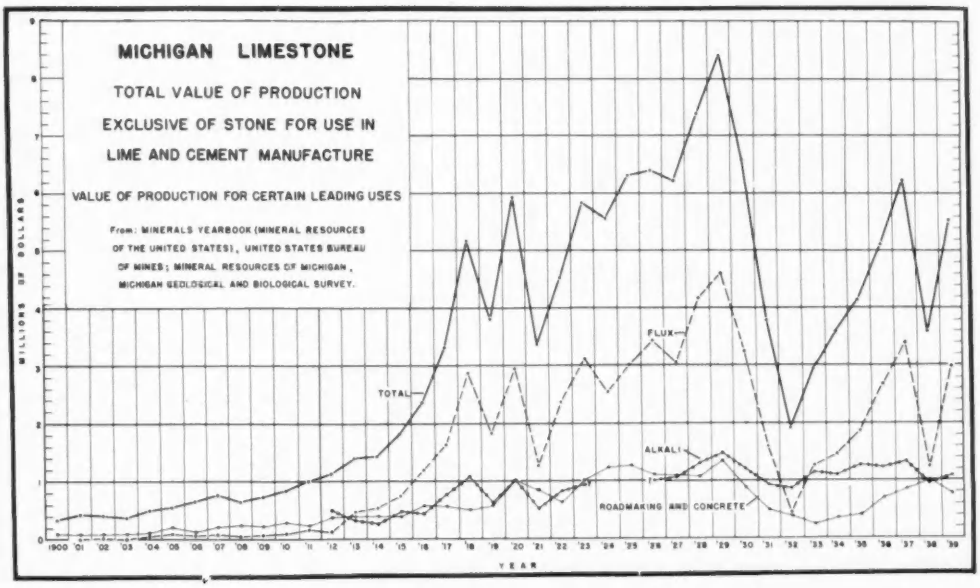
MICHIGAN LIMESTONE
TOTAL VALUE OF PRODUCTION
EXCLUSIVE OF STONE FOR USE IN
LIME AND CEMENT MANUFACTURE
VALUE OF PRODUCTION FOR CERTAIN LEADING USES
From: MINERALS YEARBOOK (MINERAL RESOURCES OF THE UNITED STATES), UNITED STATES BUREAU OF MINES; MINERAL RESOURCES OF MICHIGAN, MICHIGAN GEOLOGICAL AND BIOLOGICAL SURVEY.
MILLIONS OF DOLLARS
TOTAL
FLUX
ALKALI
ROADMAKING AND CONCRETE
YEAR

FIGURE 2.—Unfortunately, no records are regularly kept by the Geological Surveys of the various states concerning the production of stone for use in cement and lime manufacture. Such stone is reported in terms of finished lime and cement only. In Michigan, stone quarried for these two purposes in 1937 amounted to 3,341,241 short tons. Almost half of this stone was shipped out of the state for use, and was thus reported as lime or cement, not from Michigan, but from another state. The exclusion of this stone from the Michigan total gives an incomplete impression concerning the importance of Michigan quarries in national limestone production and trade.

for building stone and the burning of lime. Although wood was plentiful and cheap, stone was needed for fireplaces, chimneys, and foundations, and lime for mortar and plaster. Transportation being difficult, these bulky materials even though of inferior quality were of necessity produced near the consuming point. The lime, in addition, was an unstable product subject to slaking.

By 1900, utilization of the limestones of northern Michigan was well underway, especially in Huron, Alpena, and Emmet Counties in the Southern Peninsula, and Delta and Schoolcraft Counties in the Northern Peninsula. Meanwhile, many of the early quarries had been abandoned. Exhaustion of cheap wood fuel supplies, especially in the southern part of the state, along with the superiority of lime shipped in from Ohio, had forced the abandonment of some of the early lime kilns and their associated quarries. Other small kilns and quarries had fallen into disuse as soon as the first rush of local demand for building stone and for mortar and plaster for settlers' homes subsided. Also, the character of the Michigan limestone deposits made difficult the production of a uniform building stone without excessive quarry waste. As transportation improved, more satisfactory building stones could be cheaply imported from outside the state.

During the decade 1890–1900, the Michigan limestone industry nevertheless made a large growth. This was because of the development of new markets for stone. Improvement of roads was receiving increased attention, and the demand for crushed stone for this purpose and for steam and electric railway ballast grew rapidly. At Detroit, the Michigan Alkali Company began operations in 1889 and the Solvay

Process Company in 1897. Michigan's first beet sugar refinery was opened in October, 1898, and the industry quickly attained prominence.

The development of these new uses may be said to have brought the early history of the Michigan limestone industry to a close. Before this time quarries were small, human and animal muscle furnished most of the power, and markets were largely local. Quarry output in 1900, the largest up to that time, was valued at only $425,636. The most productive quarries were located at Bayport, Huron County; Sibley, Wayne County; Monroe, Monroe County; and Bellevue, Eaton County. Development of the present large quarries in northern Michigan still lay in the future.

Soon after 1900 additional important uses for Michigan limestone developed. Use for cement manufacture began in April, 1901, when the Alpena Portland Cement Company began operations at Alpena, using limestone from the Alpena formation. Production of fluxing stone for the iron and steel industry, which had been largely for use by charcoal iron furnaces within Michigan before 1900, increased considerably between 1900 and 1913, much of the production now being shipped out of the state.

In 1913, with the opening of the Michigan Limestone and Chemical Company quarry at Calcite, Presque Isle County, Michigan flux stone production increased more than one million tons. Flux stone for the first time was the most important product of Michigan quarries, a position since retained except for the year 1932.

After 1900, production of Michigan limestone increased with but few interruptions until 1929, when a record high of 19,077,000 short tons, valued at more than $12,500,000 was produced for all uses (Figure 2). Three years later, in 1932, because of the great business depression, production was roughly only about one-quarter of that of 1929 and was the lowest in many years. Subsequent recovery was interrupted only by the business recession of 1938. Because of demands engendered by the war effort, the record production of Michigan quarries in 1929 was doubtless exceeded during 1941.

FIGURE 3.—Quarries active in 1937, with year of establishment (in parenthesis) of larger quarries: 1. France Stone Company, Monroe (about 1905). 2. Solvay Process Company, Sibley (very early). 3. Wallace Stone Company, Bayport (1888). 4. Arenac County Road Commission, near Omer. 5. Iosco County Road Commission, near Whittemore. 6. Michigan Alkali Company, Alpena (1903). 7. Thunder Bay Quarries Company, Alpena (1931). 8. Kelley Island Lime and Transport Company (1932). 9. Michigan Limestone and Chemical Company, Calcite (1912). 10. Petoskey Portland Cement Company, Petoskey (about 1910). 11. Antrim Lime Company, Petoskey. 12. Northern Lime Company, Petoskey. 13. Fiborn Limestone Company, Ozark. 14. Inland Lime and Stone Company (1930). 15. Inland Lime and Stone Company dolomite quarry, Port Inland. 16. Bickler Brothers, Groos. 17. Metro-Nite Company, Felch. 18. Superior Rock Products Company, Randville. Larger abandoned quarries with dates of operation (in parenthesis): A. Alpha Portland Cement Company, Bellevue (before 1900–1931). B. Kelley Island Lime and Transport Company, Rockport (1915–1932) (Crushing plant and dock for company's active quarry, No. 8 above, are also here). C. Campbell Stone Company, Afton (about 1908–1934). D. Fiborn Limestone Company, Fiborn (about 1905–1936). E. Union Carbide Company, Hendricks (about 1905–1921).

Twenty-nine Michigan quarries operated in 1904. Ten of these were in Monroe County, four each in Alpena and Emmet Counties, two each in Chippewa, Delta, Kent, and Wayne Counties, and one each in Charlevoix, Huron, and Schoolcraft Counties. Thirty-four quarries, probably the greatest number ever to operate in a single year, produced stone in 1916. By 1937 the active quarries had declined to eighteen. The general location of these is shown in Figure 3. Only two were in the southern part of the state. Seven of the quarries, each producing roughly 500,000 or more tons of stone, accounted for approximately 97 per cent of the tonnage and 94 per cent of the value of Michigan production. Why is the Michigan limestone industry so dominated by a few large quarries and why have the centers of the industry largely shifted to the northern part of the state?

DEPOSITS FAVOR LARGE SCALE UTILIZATION

For uses such as road metal, aggregate, and railroad ballast, the chemical qualities of limestone are less important than the physical properties, but for most chemical uses, such as the manufacture of alkali, cement, iron and steel, and sugar, a high calcium stone is usually desired. Though limestone is a common and widely distributed rock, deposits of nearly pure high calcium stone are much more restricted. Michigan is fortunate in having extensive high calcium deposits, so situated as to be highly favorable for large-scale exploitation.

Most important are the Dundee limestone of Presque Isle County, the Alpena limestone, and the Fiborn limestone, the latter located in the Burnt Bluff formation in eastern Schoolcraft and western Mackinac Counties (Figure 1). All are very pure limestones, generally averaging over 95 per cent of calcium carbonate. In few places does this content drop below 90 per cent, and many analyses show it to be over 99 per cent. The Traverse limestone quarried at Petoskey is only slightly less pure. The somewhat lower calcium carbonate content of the limited exposure of Dundee strata at Sibley, Wayne County, is offset by the advantageous situation in reference to a large market. This stone averages about 85 per cent calcium carbonate, though some beds analyze well over 90 per cent. The seven large quarries, to which most of the following discussion specifically applies, operate in the above deposits. These deposits, excepting that at Sibley, are located in northern Michigan.

FIGURE 4.—North face of Michigan Alkali Company quarry. Thin overburden (left) has been ridged up in stripping. Note smooth surface and level bedding of stone.

Considerable areas of the high calcium limestones lie at the surface, or under only a thin cover of glacial debris. Rarely is removal of stone of inferior grade necessary to expose marketable strata. Overburden near the large quarries ranges from outcrop to twenty or more feet, but in general averages less than six to eight feet in thickness. In addition, the surface of the limestone is comparatively smooth so that clean stripping of overburden with large steam or electric shovels is possible (Figure 4).

The beds exposed by stripping have but slight dip, with only minor sags and swells disturbing their regularity. This has facilitated establishment of large "open pit" quarries (Figure 5). In some places escarpments formed by outcrops of the slightly dipping beds, especially near the shores of the Great Lakes, have invited the opening of "cliff" or "shelf" quarries. The quar-

FIGURE 5.—Quarry pattern at Alpena. A. Thunder Bay Quarries Company quarry, crushing and screening plant, stock piles, and dock. B. Michigan Alkali Company quarry, crushing and screening plant, stock piles, and dock. C. Huron Portland Cement Company plant and dock. D. Abandoned quarry and plant of the Alpena Portland Cement Company. E. Land made from quarry strippings and plant waste, and strippings dump of Thunder Bay Quarries Company quarry. F. Abandoned pits of early quarries. G. Thunder Bay River and part of Alpena. (Courtesy U. S. Dept. of Agriculture.)

FIGURE 6.—Self-unloader taking on stone at dock of the Thunder Bay Quarries Company, Alpena. Stacks of the Huron Portland Cement Company are visible in the background at prow of boat, and docks of the cement company and of the Michigan Alkali Company quarry in the background at the right. (Courtesy Thunder Bay Quarries Company.)

ries of the Inland Lime and Stone Company, the Michigan Alkali Company, the Thunder Bay Quarries Company, and the Solvay Process Company are "open pit" operations; those of the Petoskey Portland Cement Company, the Michigan Limestone and Chemical Company and the Kelley Island Lime and Transport Company started as "cliff" operations.

The workable deposits not only underly extensive areas, but are very thick. The Alpena limestone, for example, has been quarried to a depth of 100 feet; the Dundee limestone of Presque Isle County has a maximum thickness of nearly 250 feet, and the Fiborn limestone is in places 60 or more feet thick.

Variation of composition within strata, impurity in separate strata, and impurities in the form of lenses, thin beds, streaks, filled erosion cavities, pockets, etc., are generally so negligible as to have little effect on the final quarry product when the stone is properly blasted down and blended in the loading and crushing operations. This makes possible the use of large mechanical shovels in quarry loading, and mass production methods. Furthermore, the beds are not generally so massive as to cause undue difficulty and expense in extraction and crushing, nor yet so thin and seamy as to result in excessive shattering and a wasteful production of "fines."

Formerly, fines were considered a troublesome by-product. More recently, changing technology in cement manufacturing has provided an important use for these fines, and large amounts have been reclaimed from dumps formed during earlier operations. When production of flux and chemical stone is great, a supply of fines and smaller sizes in excess of the demand is often produced, but when the demand for flux and chemical stone is low, and by-product production of fines consequently lower, as during the business recession of 1938 and during steel strikes, recovery of fines from storage dumps is often necessary. Several quarries have installed machinery for manufacturing sand from the fines, as another means of disposing of them.

Reserves contained in the larger high calcium limestone deposits of Michigan are sufficient to last many years, even at a greatly increased rate of use. In Alpena County alone, a state geologist has estimated that there are five billion tons of high calcium stone available under overburden of less than ten feet. Over half is close to lake transportation. Tremendous additional reserves exist in the Dundee limestone of Presque Isle County, the Fiborn limestone of Mackinac and Schoolcraft Counties, and the

Traverse limestone near Petoskey, Charlevoix, and in the northern interior of the Southern Peninsula, as near Afton in Cheboygan County. Reserves under thin overburden in Wayne County are limited, however.

The cost of limestone lands to quarry companies was generally not high. In 1911, for example, thousands of acres of limestone lands in Alpena County were available for five to fifteen dollars per acre. Limestone is a low-priced commodity. Most of its value at the quarry is that added by the costs of extraction and processing. Thus, the mere presence of limestone usually added little or nothing to the value of the land, and once the timber was cut off, the land was of little use for agriculture because of thin rocky soils. Regrowth of the forest was slow for the same reason. Much of the limestone land is now covered with second growth aspen-brush, conifer swamp, or mixed hardwood and softwood associations of no great commercial value and offering little handicap to quarry operations. Consequently, quarry companies were able to acquire large blocks of land at nominal cost. This assured the companies of a supply of stone great enough to permit establishment of large quarries, with reserves for many years of operation.

Most of the more desirable high calcium limestone lands are now in the hands of operating companies, or in the hands of the users of limestone. The latter, though not now operating quarries, have purchased limestone land for possible future use, and as a means of keeping down the prices of producers from whom they purchase present supplies.

The holding of the large reserves of stone is favored by moderate valuation of idle limestone lands for tax purposes. From the standpoint of public income, it is desirable that these lands not be overtaxed, for if not held by the quarry companies, much of this cut-over land would revert to state ownership. Assessed valuations commonly vary from $2.50 to $25.00 per acre. Valuations in the Northern Peninsula usually do not exceed $10.00 per acre, much of the land there being taxed at the $2.50 figure. The above discussed advantages would have largely gone for naught, however, had the deposits not been favorably located to large markets.

FIGURE 7.—Part of the Michigan Limestone and Chemical Company quarry, said to be the largest in the world. Almost 11,000,000 tons of stone were shipped by water from this quarry in 1929, according to the Annual Report of the Chief of Engineers, United States Army. (Courtesy of L. Claire Hulbert.)

THE FORTUNATE LAKESIDE LOCATION

Limestone is a low-priced, bulky commodity. It ordinarily cannot stand the cost of transportation to distant markets. This is especially true because limestone deposits are common in most parts of the country, and even though local deposits are inferior in quality, they are often used in preference to higher quality stones from more distant points if freight costs on the latter are excessive. Most Michigan deposits lie in the northern part of the state, considerably removed from the nation's large manufacturing and commercial centers. If it were not for the fortunate location of these deposits on or near the Great Lakes, they would probably be but little used. Cheaply transported in large bulk freighters and in specially constructed self-unloading boats, Michigan limestone reaches markets along the shores of the lakes from Duluth and Chicago to Buffalo (Figure 6). That Michigan quarries are centrally located with reference to these lakeside markets is apparent if a map of the Great Lakes region is consulted. It is significant that all but one of the large abandoned quarries in Michigan are located in the interior of the state (Figure 3).

Among the bulk commodities transported on the Great Lakes, stone often ranks third in tonnage. Most of this stone is from Michigan quarries. Approximately 83 per cent of all limestone produced in Michigan in 1937 was shipped by boat. Almost 80 per cent of this reached markets outside of Michigan, some nearly 700 miles away. Boat rates do not exceed $.55 or $.60 per gross ton for even the longest haul. The delivered price of limestone at Great Lakes ports is usually between $1.00 and $1.25 per gross ton.

Stone like iron ore moves down lake. Only small amounts pass into Lake Superior and almost none into Lake Ontario. Michigan ports of origin are Calcite, Port Inland, Alpena, and Rockport. Shipments in 1937, in short tons, were Calcite, 7,307,780; Port Inland, 2,426,741; Alpena, 2,209,305; and Rockport 735,373. In a single season, over 1,000 boatloads of stone have moved from Calcite alone (Figure 7). Important receiving ports are Calumet Harbor and River, Buffalo, Gary, Cleveland, Fairport, Wyandotte, Indiana Harbor, Lorain, River Rouge, and Buffington.

The lakeside location of the quarries also facilitates the procuring of necessary supplies of coal for generating the large amounts of power used in the quarry operation. This coal can be cheaply transported from Lake Erie ports by boats returning to the quarry after delivering stone. Coal laid down on the quarry docks amounted to a quarter of a million tons in 1937.

Further, the lakeside location makes available cheap water for use in power plant generators, and for washing stone. For the first use the water must be clear and cold; for the second use a large volume is needed. From 200 to 300 or more gallons of water are used in washing a ton of stone. Larger sizes of stone, especially those used for alkali manufacture and for flux are generally not washed, however. Used water passes back into the lake through settling basins and ditches.

CLIMATIC RELATIONSHIPS

Michigan winter temperatures are unfavorable for efficient quarry operation. The average temperature of the coldest month at Detroit is 24.5 degrees, at Alpena, 17.7 degrees, at Petoskey, 17.9 degrees, and at Manistique 16.7 degrees. Coldest temperatures on particular days may drop as low as 20 to 30 degrees below zero.

The most important effect of the cold

winters is the closing of transportation on the Great Lakes for a four- or five-month period. While demand for stone for certain uses, such as for road and concrete work and for the manufacture of cement, is also somewhat curtailed during cold weather, the demand for stone for other important uses is more regular. Stoppage of lake transportation is therefore a distinct disadvantage. It necessitates a larger quarry equipment investment than would otherwise be necessary, and thus increases the overhead cost of production per ton. Sufficient stone must be quarried and transported during the shipping season to supply both current demand and that needed during the period of closed navigation. On the part of the consumer, an increased investment in storage facilities is required. Excepting the Solvay Process Company Quarry at Sibley, which ships stone almost entirely by rail, operations at the large Michigan quarries are either greatly reduced or ceased entirely during the winter months. Some quarries have partly solved the problem of seasonal demand for labor by carrying out stripping and drilling operations, and plant construction and repairs during the winter months. Some of the men laid off obtain work in the woods, cutting ties, posts, firewood, and timber.

Winter cold handicaps any quarry operation where men are outside and unprotected, however. Alternate freezing and thawing can result in bad conditions for stripping, since expansion and contraction of the material being stripped makes precarious track conditions for transportation units. Freezing and thawing also causes bad ice conditions, making it difficult and dangerous for workmen to walk without calks or creepers. Quarry haulage may be slowed if rails become frosted. Occasionally water lines freeze up. Heavy winter snows slow stripping, shovel, and locomotive operations, and may cause entire suspension of activities.

FIGURE 8.—This huge shovel loads fifteen to twenty tons in one dip. Note size of workmen, and of locomotive cars. (Courtesy Michigan Limestone and Chemical Company.)

The average mildness of summer temperatures, on the other hand, is of undoubted advantage in increasing the efficiency of the quarry laborers, subjected as they are to an increased intensity of the sun's heat because of reflection from the bare rock surfaces. Summer temperatures closely approximate 64 degrees, which is the optimum summer temperature for physical health and energy according to Ellsworth Huntington. The average temperature for the warmest month at Detroit is 72.3 degrees, at Alpena 65.9 degrees, at Petoskey 66.7 degrees, and at Manistique 64 degrees. The warmest days to be expected have temperatures approaching or slightly exceeding 100 degrees, but such days are not numerous.

Heavy summer rains sometimes cause partial flooding of a quarry, necessitating drainage by pumping, and the shifting of shovel positions, but generally the quarries are free of the evil of too much water, either from heavy rain or excessive ground water.

THE INDUSTRY IS HIGHLY MECHANIZED

When the demand for limestone was small, and specifications less exacting,

the supply could be provided from small local sources. To supply cheaply the tremendous amount of stone needed by modern industry, however, quarry operations must be on a large scale and highly mechanized, and only the richest available deposits used. Rough estimates by the author, based on water shipments and information furnished by quarry operators, place total stone production in short tons through 1938 approximately as follows: Michigan

FIGURE 9.—Screen house, conveyor galleries, and stock piles at Calcite. (Courtesy Michigan Limestone and Chemical Company.)

Limestone and Chemical Company, 145,000,000; Michigan Alkali Company, 40,000,000; Solvay Process Company, 25,000,000; Kelley Island Lime and Transport, old quarry 15,000,000, new quarry 3,000,000; Inland Lime and Stone Company 7,500,000; and Petoskey Portland Cement Company 3,500,000.

Quarrying today in the larger Michigan quarries is as nearly automatic as is possible. Prime movers used in 1902 totaled 1,449 horsepower. By 1929 this figure had increased to 24,385 horsepower, and is still larger today. Enormous amounts of electrical power are used, much of it being generated by the quarry companies.

Production costs per ton are low as long as a large volume is produced, spreading fixed costs over many units. The desire for large production volume causes severe competition for the markets. This keeps prices to the consumer down and results in continuous effort to increase quarry efficiency through the use of improved machinery. Rapid equipment obsolescence thus becomes an important problem.

Quarry operations consist of stripping, drilling, blasting, loading in the quarry, haulage to the crushing plant, crushing, screening and washing, storage, recovery from storage, and loading for shipment.

Blast holes are drilled by electrical or gasoline powered churn drills. Enormous quantities of explosives are used. The Michigan Limestone and Chemical Company, for example, used 1,784,000 pounds of explosives in 1929, when nearly 11,000,000 tons of stone were shipped from the quarry dock. Between the beginning of operations in 1912, and 1929, workmen in this quarry loaded and fired approximately 16,500,000 pounds of explosives (R. Dueltgen, Jr.: Blasting Crew Has a Remarkable Record Over a Period of Years, *Calcite Screenings*, December, 1929, pp. 14–15). On March 16, 1932, a tremendous blast, apparently the largest commercial blast on record, was set off at the Inland Lime and Stone Company quarry. Thirty-eight miles of fuse and 440,966 pounds of explosives were used in over 4,000 blast holes (A. J. Cayia; Record Breaking Blast at Manistique Quarry, *Rock Products*, Vol. 35, No. 8, 1932, pp. 64–66).

Most quarries use full revolving, caterpillar mounted, electric shovels for stripping overburden and loading blasted down stone. One quarry uses caterpillar mounted steam shovels and one still uses steam shovels mounted on railroad trucks. Shovel buckets are commonly of 5 cubic yard capacity but the shovels used by the Michigan Limestone and Chemical Company have 14 and 18 cubic yard buckets. The latter can

load more stone in one scoop than could a man in a day of hard hand labor (Figure 8).

Transportation from the shovels to the crushing and screening plant is by steam, diesel, or electric locomotived trains, operating on standard gauge track. Cars vary in size at different quarries, but are commonly automatic side dump cars of 25 to 50 cubic yard capacities. The number of cars per train also varies. At the Michigan Limestone and Chemical Company quarry, and at the Inland Lime and Stone Company quarry, 12 to 15 car trains transport between 700 and 1,000 tons of stone to the crushing plant each trip. The longest haul is about seven miles; between the Inland Line and Stone Company quarry and the crushing plant at Port Inland.

The crushing and screening plants, substantial buildings of concrete and steel, house huge masses of heavy machinery tied together by large belt conveyors (Figure 9). Gargantuan crushers quickly reduce blocks of stone as large as an office desk into minus 12 inch pieces (Figure 10). From the crushers, stone is moved through the screening and washing machinery to the storage piles by gravitational flow and belt conveyors. Stone has been quarried, crushed, screened, and stockpiled at the rate of 60,000 tons in a twenty-hour day at the Michigan Limestone and Chemical Company quarry.

Recovery from storage is by belt conveyors operating in tunnels under the storage piles. From the tunnels the stone is delivered by these conveyors to loading shuttles on the docks. Older pocket type docks at two quarries (similar to the upper lake iron ore docks) have been modernized by the addition of loading shuttles, so that but little stone is today spouted by gravity into the ships holds. Breakage in loading has consequently been reduced. Loading rates vary, according to the size of the stone being loaded and the dock equipment, between 1,000 and 3,600 tons per hour. However, the Conneaut, which holds the Great Lakes record for loading limestone, took on 7,145 net tons of stone in 38 minutes at the Michigan Alkali Company quarry dock on June 26, 1926. (*Transportation on the Great Lakes* [*Rev. 1937*], Corps of Engineers, U. S. Army, Transportation Ser. No. 1, 1937, p. 35.) This was accomplished because the boat docked without ballast.

LARGE CAPITAL INVESTMENT AND INTEGRATION WITH OTHER INDUSTRIES

The corporate form of organization is typical of the Michigan limestone industry. Investment in individual companies is large. Total assets of the industry approximate $20,000,000.

Because certain manufacturing industries use enormous amounts of limestone, it is not surprising that these have expanded vertically to gain control of the production of this raw material. Many of the quarries, consequently, have had the double advantage of having large amounts of capital available for development and an assured market for a large part of their production. The quarries of the Michigan Alkali Company, the Solvay Process Company, and the Petoskey Portland Cement Company, are integral parts of the holdings and operations of these companies. The Michigan Limestone and Chemical Company is a subsidiary of the United States Steel Corporation, the Inland Lime and Stone Company of the Inland Steel Company, the Thunder Bay Quarries Company of the Diamond Alkali Company, and the Fiborn Quarry Company of the Algoma Steel Corporation, Ltd. The quarry of the Kelley Island Lime and Stone Company and

that of the France Stone Company are each one of a number of quarries operated in different states by these companies. Other corporations, as the Ford Motor Company, the Aetna Portland Cement Company, and the Great Lakes Portland Cement Company, have acquired large tracts of limestone land, but have not yet opened quarries.

FIGURE 10.—Primary crusher building at Port Inland. Stone is being dumped into the crusher, one car every two minutes.

Transportation of limestone is largely by water, often in specially constructed self unloading boats, so one might also expect the large consumers to control transportation to some extent. Most of the stone shipped from the Michigan Limestone and Chemical Company, for example, moves in vessels of the Bradley Transportation Company and the Pittsburgh Steamship Company, both subsidiaries of the United States Steel Corporation (Figure 11). The Wyandotte Transportation Company is owned and operated by owners of the Michigan Alkali Company. Other boats are operated by such consumers as the Ford Motor Company, the Inland Steel Company, and the International Harvester Company.

FAVORABLE MANAGEMENT AND LABOR CONDITIONS

Large companies can afford to pay salaries high enough to attract superior managerial ability. The larger Michigan quarries do not lack capable managers and technical experts, the more so because the quarries are usually allied with even larger industrial enterprises. In 1929 fourteen salaried corporation officers employed by Michigan quarries received together $114,278 in salaries. Salaries of 124 other salaried officers and employees totalled $303,783.

Obtaining labor for quarrying has generally not been a problem. Lumbering attracted most of the early settlers to northern Michigan. Others, seeking land for agriculture, followed the lumbermen. The lumber resource was soon exploited, and it was discovered that much of the cleared land was submarginal for crop production. Consequently, despite relative sparsity of settlement, a surplus population has welcomed the opportunity of employment in the quarries.

With passage of time, a considerable body of experienced quarry workers has been built up. This has been an advantage in opening new quarries. Many of the present employees have been engaged in the quarry industry for most of their working lives. Labor turnover is small.

Employment probably reached a peak in 1929, when production was the highest ever attained. An average of 1,566 wage earners were employed that year, not counting 287 workers employed in quarries operated by cement manufacturers. During July, the peak month of employment, 1,919 men were on the pay rolls, not including the wage earners in the quarries of the cement manufacturers. During recent years employment has been lower because production has been less. Indications are that an average of between 1,500 and 1,750 men have been employed during these years.

The number employed in 1929, was less than three times larger than in

1902, although salaries and wages paid had increased almost eight times and production nearly twenty times during the same period. The pronounced growth in output per man employed was a reflection of the greatly increased mechanization of quarry operations. Mechanization expanded employment, however, because it so cheapened the per ton cost of production that the demand for limestone for various uses increased enormously. Many more workers were now needed than when stone was produced by hand and used largely for lime burning and building blocks.

About 35 to 40 per cent of the wage earners are classed as skilled laborers. Experience and intelligence are necessary in the proper handling of explosives, and in operating such machines as shovels and locomotives. The heavy use of much machinery and the comparative isolation of the quarries requires a large force of trained mechanics for repair work. For these and other jobs a body of skilled workers is needed. The major work around the quarry, however, requires heavy manual labor, or consists of starting, stopping, and checking on the operations of highly automatic machines. For these jobs common labor suffices. Even so, the low labor turnover is a distinct advantage.

The workers, as a whole, form an intelligent, energetic group. Over 90 per cent are native born Americans, predominantly of Nordic descent. Poles are numerous in the quarries of Alpena and Presque Isle Counties; Italians in the Solvay Process Company quarry in Wayne County. By far the most important labor problem is the seasonal demand. The 1,434 workers employed in 14 of the 18 Michigan quarries operated in 1937, averaged 255 days of employment per man (Adams and Wrenn: Quarry Accidents in the United States, 1937, Bur. of Mines, Bull. 426, 1940, p. 43).

Under the Fair Labor Standards Act of 1938, men cannot be worked over 40 hours per week without the payment of overtime at the rate of at least one and one-half times the regular hourly rate of pay. The quarries have thus been forced either to employ more men in summer than formerly, or to pay overtime. Employment of more men requires payment of greater fees for workmen's unemployment compensation and other benefits, however, especially since the additional workmen will be laid off several months of the year. Laborers usually receive a minimum of 45 or 50 cents per hour. Relations of labor and management have as a whole been satisfactory.

FIGURE 11.—Two Bradley Transportation Company self-unloaders in the Calcite slip. In right foreground is a coaling shuttle; beside the vessels are stone loading shuttles. (Courtesy of Michigan Limestone and Chemical Company.)

SUMMARY

In the years following 1900, new uses not only resulted in the utilization of Michigan limestone on a gigantic scale, but also in a demand for limestone with special characteristics. Since most of the chemical uses of limestone, and these are by far the most important, require the stone to be as nearly pure and high in calcium content as possible,

search was instituted for such deposits. It was discovered that Michigan was fortunate in having large, thinly covered deposits of very pure, high calcium stone in the northern part of the state, some conveniently located on or near the shores of the Great Lakes.

Quarries were opened—some even in deposits in the interior. As the competitive advantages afforded by cheap water transportation possessed by the water front quarries became evident, however, the interior quarries were largely abandoned. This has resulted in the concentration of the major part of the Michigan production in a few large, highly mechanized quarries operated in the rich and extensive lakeside deposits. Considering the prospective permanence of the large markets served, the large reserves of stone, and the other highly favorable economic and geographic factors, the future importance of the Michigan limestone industry seems assured.

CUYUNA IRON RANGE

George F. Brightman

THE Cuyuna Range is one of the six iron mining ranges in the American portion of the famous Lake Superior district, from which comes four-fifths of the iron ore mined each year in the United States. The Cuyuna Range normally furnishes only between 2 and 4 per cent of this large tonnage; it is far overshadowed by the Mesabi Range, and in recent years has been exceeded in production by almost all the other ranges. In spite of its relatively small output, however, the Cuyuna Range is an important element in the industrial structure of the United States, for it is the only large producer of manganiferous iron ores, and it is a possible source of ferromanganese, a strategic material which is of vital importance in steel production, and in which domestic production is notably deficient.

The Cuyuna Range is situated in central Minnesota, near the southern edge of the sparsely populated, cut-over coniferous forest lands. It lies about a hundred miles north of Minneapolis, and some eighty miles west of Duluth (Figure 1). The mines are grouped in two separate areas, locally called the North Range and the South Range. All of the mines on the South Range, however, have been inactive for twenty years or more; the railroad spurs which served them have been torn up, and the remains of their headworkings are overgrown with brush, so that but few traces of mining may be seen in the landscape.

Present-day mining activity is limited to the North Range, and even there it is concentrated in a small area of only six square miles, lying between Ironton-Crosby and Trommald, and one small outlier a few miles to the southwest, at the little village of Riverton (Figure 2). Within these two small areas, however, mining activity dominates the landscape, accounting for nearly every cultural feature. Here there are the great open-pit mines, found nowhere else on the range, some of them more than half a mile long and over 200 feet deep (Figures 3 and 4). Scattered through the area are the headworkings, most of them abandoned, of underground mines. "Caving grounds," areas where the surface has subsided as a result of underground mining, may be seen in the vicinity of some of the shafts. Great dumps of waste rock, and stock-piles of lean ore are very conspicuous. From the air they appear as fan-shaped areas, with radiating "ribs" which mark the shifts in location of the railroad tracks along which the material is dumped. On the ground these features are equally prominent, with their level, plateau-like tops and abrupt slopes at the ends and sides. Beneficiation plants, where much of the ore is treated before shipping, are another element in the landscape (Figure 5), and railroad tracks and roads are everywhere, forming a close network.

Almost everything is a dull rusty red. This is the color of the railroad ties, of the soil, of the stockpiles, and even of the buildings at the mines. The landscape has a blasted and forlorn look, and even though many of the mines are operating, somehow always seems lifeless and desolate. This is partly because of the unused, water-filled pits, and the gaunt, abandoned shaft-heads which are interspersed among the active mines.

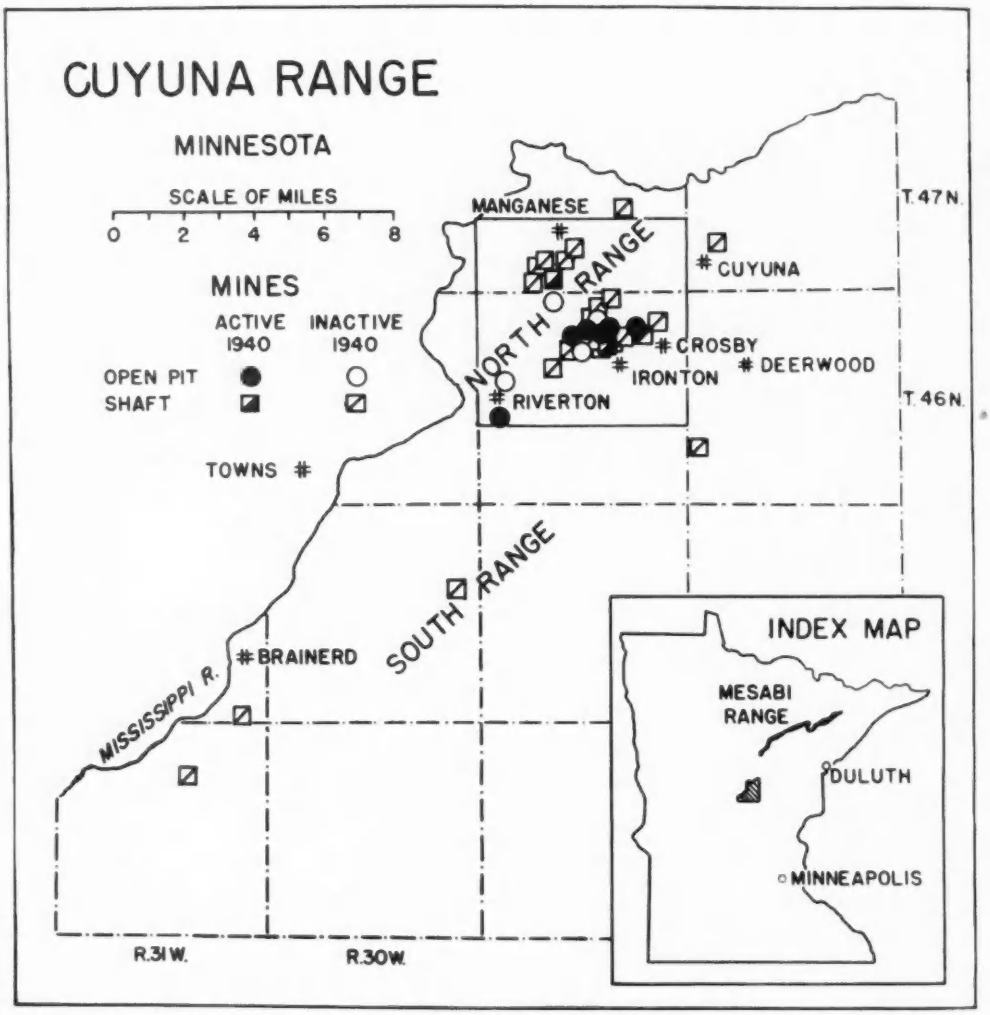

FIGURE 1.—Location of mines comprising the North and South ranges. The area enclosed within the small rectangle is shown, mapped in more detail, in Figure 2. On the inset map of Minnesota is indicated the location of the range, in relation to Minneapolis, Duluth, and the Mesabi Range.

But even in pits which are being worked, the steam shovels and the handful of men involved are dwarfed by the great expanse of stripped area, and the two active underground mines do not give much evidence that they are in operation, beyond the occasional appearance of a car of ore or waste.

Geology furnishes the first key to an understanding of this apparently confused and patternless arrangement of mines, set down anomalously within the forest. The rocks in which the iron ore is found do not outcrop anywhere on the range; the ledge, as the top of the bed rock is called, lies 25 to 100 feet or more beneath the slightly rolling surface of a mantle of glacial drift. (The word "range," incidentally, may seem something of a misnomer for an area of this sort, but as used in the Lake States it does not necessarily imply any relief feature, and is applied indiscriminately to all of the iron mining areas.)

The absence of outcrops has been

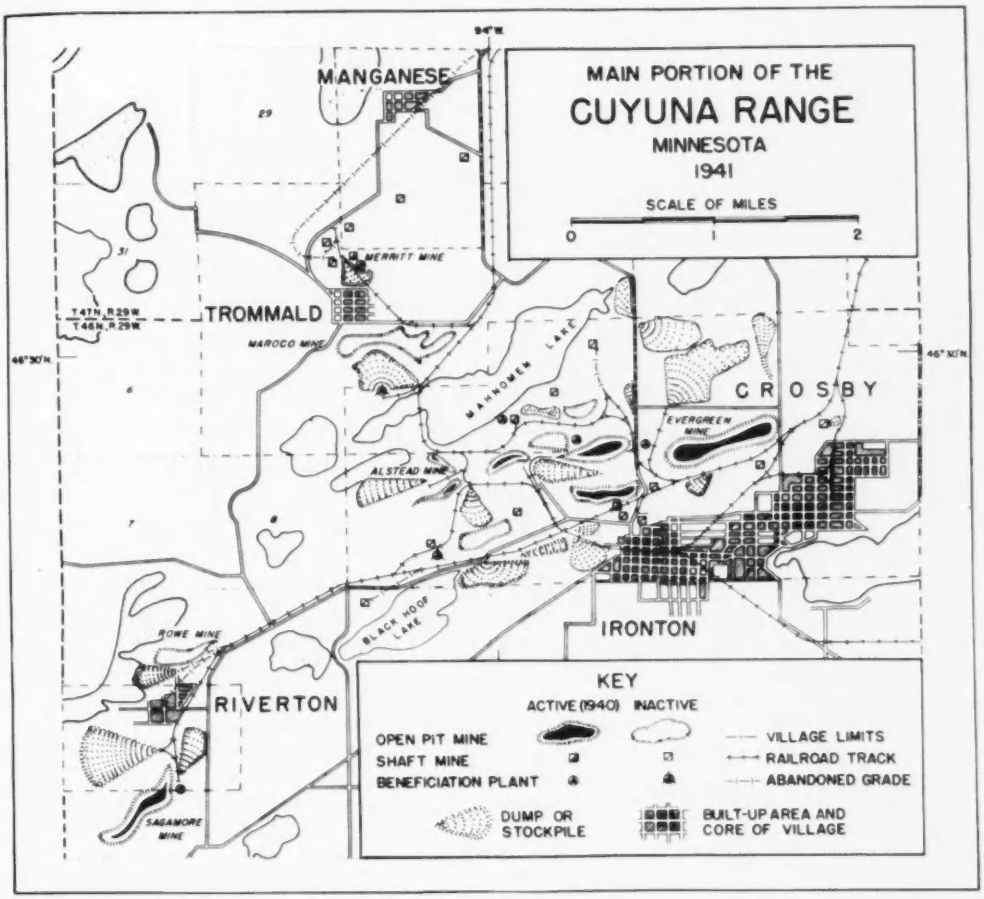

FIGURE 2.—The main portion of the North Range of the Cuyuna. All of the active mines, and all of the open-pit mines lie within this area.

responsible, in large part, for the relatively late development of the range, which was the last of the Lake Superior group to come into production. Exploration must be done entirely by measuring magnetic attraction, and by extensive drilling, and the thick overburden, which is often saturated with water, forming "quicksand," increases the difficulty of both open pit and underground mining.

The rocks which underlie the glacial drift are slaty and schistose metamorphosed sediments and interbedded tuffs and lavas. The ore deposits do not occur at random within these rocks, but are found only within the iron-formation, which is a metamorphosed cherty iron-carbonate rock. The rocks have been strongly folded, and the nearly level, present-day surface of the bed rock truncates these folds. As a result the iron-formation is not exposed over wide areas, but occurs in narrow belts where the edge of the steeply dipping beds "outcrops" beneath the glacial drift (Figure 7).

Not all, by any means, of the iron-formation is ore. Workable deposits are found only in spots where leaching by descending surface waters has removed silica, and otherwise altered the original composition of the rock, increasing its iron content. This concentration

apparently took place following folding, and establishment of essentially the present erosion surface, for the ores are soft, and the deposits are shallow, extending only a few hundred feet, at most, beneath the rock surface.

The general area in which the ore-bearing rocks intersect the surface, and thus the general location of the Cuyuna Range, is determined by the regional structure, which is apparently a synclinorium, pitching to the southwest. Thus to the southwest of the range the iron-formation is buried beneath younger rocks, while to the southeast, northeast, and northwest the rocks containing the iron-formation have been removed by ersoion.

The complicated tracery of the iron-formation's outcrop pattern within the range (Figure 7) is apparently an effect of close folding of two separate horizons of iron-bearing rocks, some 500 feet apart stratigraphically. (There is some difference of opinion among geologists as to Cuyuna structure. The writer has followed the interpretations of Carl Zapffe, as expressed in his "The Cuyuna Iron-Ore District," in *The Lake Superior Region—Guidebook 27*, Int. Geol. Congress, XVI Session, pp. 72–88, 1933 and "Geologic Structure of the Cuyuna Iron District, Minnesota," *Economic Geology*, Vol. 23, pp. 612–646, 1928.) On the South Range the structure is relatively simple, with the iron-formation outcropping as a single narrow band, dipping steeply to the southeast. The linear arrangement of the mines there reflects this circumstance (Figure 1).

On the North Range, however, there are many small anticlines and synclines, and some doming. The beds dip steeply, often almost vertically, and in many cases show apparent thickening by repetition due to close folding. These facts of geology have greatly influenced the pattern of mining activity on the North Range, as a comparison of Figures 2 and 7 will indicate. The

FIGURE 3.—The Evergreen open-pit mine, largest on the Cuyuna Range, located just north of Ironton. View from the east end, looking west.

mines are aligned along the outcrop of the bands of iron-formation, and the dumps and stockpiles, as well as the platted portions of the villages, are fitted into the spaces between. The concentration of open-pit mining in this one small portion of the range is explained by the structure, for only where the iron-formation outcrops over fairly large areas are open-pit operations profitable, and this is the case only where folding has caused duplication of beds, or where doming has left the usually steeply-dipping strata nearly flat-lying. The prevailingly long, narrow, and rather deep form of the pits, and their common orientation, with the long axis trending east or northeast, are likewise explained by the geological structure.

Adjustments to geological conditions explain only some of the features of mining on the Cuyuna; equally important, perhaps more important, are the effects of what might be termed the economic environment. This comprises the needs of the blast furnaces and steel mills of the lower Lakes, virtually the only market for Cuyuna iron ores, and the activities of the other ranges which also serve this market. It is the requirements of these furnaces which determines what ores are merchantable, how much tonnage is mined, and what price is obtained for the various sorts of ore. The amount and kinds of ore produced on the other ranges also influence production on the Cuyuna, since all the ranges serve the one market, with its rather inelastic demands; even the location of the other ranges, insofar as it makes for differences in shipping costs, is a significant environmental factor.

It is only in relation to this economic environment that the differences in

FIGURE 4.—An exceptionally deep open-pit mine, the Mahnomen, which lies just west of the Evergreen mine. The view is from the east end. The use of trucks to take the ore from the pit is a new practice which is gaining favor on the Minnesota ranges. Note the characteristic profile of the stockpile on the horizon at left.

FIGURE 5.—Largest beneficiation plant on the range, the sintering plant of the Evergreen Mines Company, located near the west end of the Evergreen pit, where it serves a number of mines.

chemical composition of the Cuyuna ores assume significance. Almost all of the ores run too high in phosphorus (over 0.045 per cent) to be considered Bessemer ores, but both low-phosphorus non-Bessemer (phosphorus less than 0.18 per cent) and high-phosphorus non-Bessemer ores occur. In addition, the range affords manganiferous iron ore, of which two sorts occur: black ores which contain 15 to 22 per cent manganese and around 30 per cent iron, and brown ores, which contain only 5 to 12 per cent manganese, but run somewhat higher in iron content. (Carl Zapffe, "Manganiferous Ores of the Cuyuna District, Minnesota," *Am. Inst. Min. and Met. Eng. Trans.*, Vol. 71, pp. 372, 378, 1925.)

These variations in the character of the ores are in part areal, and go far to explain why active mining is confined today to a rather small portion of the Cuyuna Range.

On the South Range the ores are non-Bessemer, with a high phosphorus content, averaging over 0.4 per cent. Ore of this sort is used in the United States in but relatively small amounts, chiefly for foundry pig iron, but the demand is more or less steady. There are large deposits of this type of ore on the Menominee Range, in Michigan, and it normally makes up around three-fourths of that range's output, being mined in sufficient amount to supply the whole demand. These ores move through the port of Escanaba; they have both a shorter rail haul and a shorter ake trip to the markets than the Cuyunal ores, which are shipped from Superior, Wisconsin. The freight differential in favor of the Menominee ores, over those of the Cuyuna, amounts to 18 or 23 cents per ton, depending on whether they go to Chicago, or to the Lake Erie ports. Since the geologic structure on the South Range is such that open-pit mining is not economically feasible, the Cuyuna ores cannot compete with those from the more easterly range, and the inactivity of the South Range is explained.

The inactivity of the group of underground mines north of Trommald is also to be interpreted in the light of both natural conditions and economic environment. The ore, which is black, highly manganiferous, and often rather high in silica, is really a ferruginous manganese ore, rather than an iron ore. The deposits are small, and mining costs high, both because underground methods must be used, and because the ore occurs in small lenses separated by masses of gangue.

The mines of this group were all opened up during the First World War, and all of them except one ceased operations abruptly in 1918. This brief flurry of activity reflected the extraordinary war-time demand for manganese. This metal is used to some extent in the manufacture of special alloy steels, but its major importance comes from its use as a deoxidizer in the preparation of ordinary steel. The manganese is consumed only in relatively small amounts; the ratio averages about 14 pounds of the metal per ton of steel. Metallic manganese is not

used, but rather one of several compounds, of which ferromanganese (an alloy of 80 per cent manganese and 20 per cent iron and carbon) gives the best results and is most economical to use.

The United States has very little ore suitable for the production of high grade ferromanganese, and prior to 1914, this country obtained most of its manganese ore from India and Russia. On the outbreak of the First World War supplies from Russia were cut off, and the amount obtained from India declined sharply. Prices increased rapidly, and under this stimulus, imports from the lower grade deposits of Brazil and Cuba increased, as did domestic production. Even so, not enough ferromanganese could be obtained, and the consumption of a less desirable alloy called spiegeleisen (20 per cent manganese, 80 per cent iron and carbon) increased. (G. A. Roush, *Strategic Mineral Supplies*, pp. 31-69, 1939.)

Under these circumstances, the black manganiferous ores of the Cuyuna, which were suitable for spiegeleisen, but not for the more desirable ferromanganese, could be mined profitably. But when the war ended and prices fell, production was no longer profitable, even though a high tariff was imposed on foreign ores in 1922. Only one mine of the group north of Trommald has been worked since the war; this is the Merritt Mine, where intermittent experiments in concentrating the ore by various processes have been carried on, although production has been small.

The ores found in the portion of the Cuyuna Range where mining is active—the area lying to the northwest of Ironton-Crosby, with an outlier south of Riverton—are more varied than in the two areas just described. Iron ores, both high and low in phosphorus, occur, and considerable amounts of brown manganiferous ore. This material has a lower manganese content (5 to 12 per cent) than the black ores, and runs higher in iron (41 to 46 per cent) and phosphorus. Early in the history of the range these ores were regarded as valueless, and they were mined only to get them out of the way. During the First World War, however, a demand arose for this material. Shipments were made in 1916 and later years, and after a brief post-war slump, production picked up and has since been on the increase.

These brown manganiferous ores are not used for the manufacture of either ferromanganese or spiegeleisen, but are mixed with iron ores in the blast furnace in order to introduce a manganese content into the pig iron. The beneficial effects of this procedure had been known for some time, but steel makers

FIGURE 6.—Headworkings of the abandoned Martin mine, about a mile northeast of Riverton. This mine has not been operated since 1918.

were reluctant to adopt it as a standard practice, prior to the development of the Cuyuna deposits. This was chiefly because the known reserves of the manganiferous ore were small, in proportion to the reserves of ordinary iron ore in the Lake Superior District, and the furnace companies felt that future supplies were not assured. (L. E. Ives, "Development of the Use of Cuyuna Range Manganiferous Iron Ores," *Lake Superior Min. Inst. Proc.*, Vol. 23, p. 92, 1923.)

The only ranges other than the Cuyuna which produce manganiferous ore are the Mesabi, the Gogebic, and the Menominee. In recent years the Cuyuna has usually accounted for two-thirds to three-fourths of the total production, and the reasons for its leadership are clear: The Cuyuna has the largest reserves of these ores, its ores run higher in manganese than those of other ranges, and mining can be done by open-pit methods, whereas on the Michigan ranges, underground mining is necessary.

Today, on the Cuyuna, all of the operating mines (except the Merritt) produce at least some brown manganiferous ore, and it is overwhelmingly the chief product of the range, comprising 83 per cent of the output in 1940. The consumption of manganiferous ore by the blast furnaces of the lower Lakes is normally between 3 and 4 per cent of the total ore used. The Cuyuna Range has, so to speak, settled down to the function of regularly supplying a major part of this demand. Under

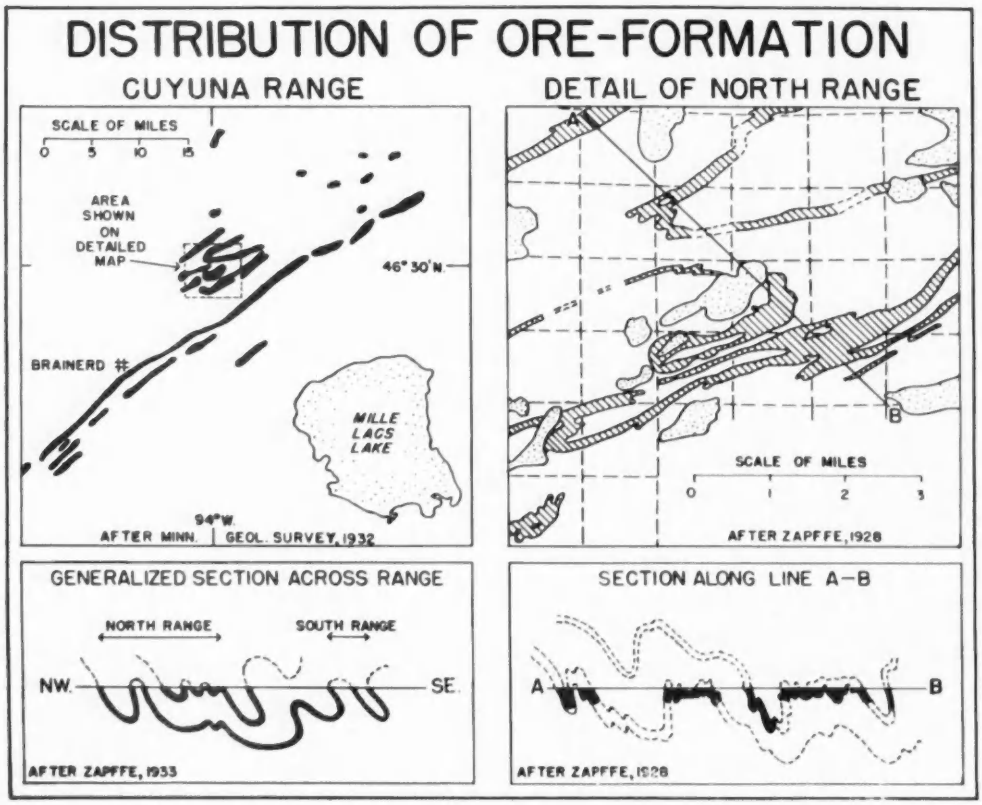

FIGURE 7.—Distribution of ore-formation on the Cuyuna Range, with a detailed map of that part of the North Range mapped in Figure 2. Comparison of these maps and cross-section with Figures 1 and 2 will show how the pattern of mining activity is adjusted to geological conditions.

these circumstances the production of the Cuyuna Range should be a direct function of the total production of all the ranges, and this is indeed the case. Since 1925, there have been violent fluctuations in the production of the range (Figure 8), but over the same period its part of the total production of the Lake Superior District has varied only between the extremes of 2.5 and 4.1 per cent.

Very little of the brown manganiferous ore is merchantable in its natural condition, and most must be beneficiated (i.e., treated to improve its composition or structure) before shipment. Since 1933 practically all of the Cuyuna ores have been treated in one way or another; one of the two active underground mines produces nearly all of the direct-shipping ore, which makes up only 5 or 10 per cent of the annual production.

The brown ores generally have a rather high moisture content, and two of the beneficiation plants are designed to overcome this handicap. At the Sagamore Mine, the ores are kiln-dried, and at the plant west of the Evergreen pit (Figure 5) the ores are sintered, that is, mixed with coke and heated in a gas furnace to the point of incipient fusion. This both dries out and agglomerates the ores, which are too powdery as mined. At the same plant there are facilities for crushing and screening the ore, and by this means it is possible to ship several grades of ore, of varying manganese content, for the brown ores are not uniform in composition, but consist of nodules of higher manganese content, imbedded in soft limonite. Treatment is simpler at the other two plants, involving chiefly crushing and mixing of ore from different parts of the properties.

The future of that part of the Cuyuna Range which is at present active, seems secure. The range's total reserves of

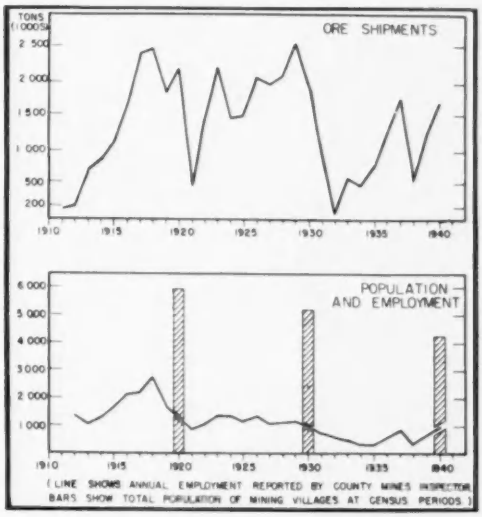

FIGURE 8.—Fluctuations in ore shipments and employment from 1911 (when the first shipment was made) to 1940. The bars show the combined population of the mining villages (Ironton, Crosby, Cuyuna, Manganese, Trommald, and Riverton) in census years. These villages include within their limits nearly all of the range. Employment figures are from reports of the Crow Wing County Mines Inspector, and represent the total number of men on the payroll during the year, without reference to length of employment.

ore still in the ground are estimated to be 65 million tons. (J. J. Craig, *Mining Directory of Minnesota, 1941*, p. 200.) Of this, probably more than half is manganiferous. (Carl Zapffe, "Reserves of Lake Superior Manganiferous Ores," *Am. Inst. Min. and Met. Eng. Trans.*, Vol. 75, p. 363, 1927.) The supply is adequate for many years, even if the annual shipments are figured at two million tons, a production which has only occasionally been obtained. Moreover, for some years the reserves have been essentially static; new supplies have been discovered at about the same rate as ore has been mined.

From the point of view of the mining communities, and of the miners, the situation is less favorable. The employment afforded by mines and plants has varied a good deal in the past, along with the fluctuations in shipments from

FIGURE 9.—The business section of Crosby, chief town of the range, with a 1940 population of 2,954. The picture was taken on a Saturday afternoon, when trade was at its height.

the range—fluctuations which bear so little relation to the range's capacity to produce iron ore (Figure 8). The peak of employment was reached in 1918, when much of the Cuyuna ore was mined underground, and since that year the curve of employment has trended steadily downward. In 1929, the year which saw the all-time high in shipments, the numbers of miners was less than half that in 1918. Open-pit mining, and increased mechanization has meant a lower labor requirement per ton of ore, and increased employment in beneficiation plants has been far from sufficient to counterbalance this change. Moreover, the shift away from underground mining has increased the seasonal character of the work, for the open-pit mines shut down during the winter months, when shipping is suspended on the Lakes.

The unfortunate situation of the miners is reflected in the character of the range towns. The largest of these are the sprawling "twin cities" of Crosby and Ironton, with 1940 populations of 2,954 and 827, respectively. They came into existence soon after the discovery of the range, and have declined in population at every decennial census since 1920; their over-wide streets, and excessively large business districts, with their many idle buildings, tell of the vanished boom, and of commercial development blighted by the proximity of Brainerd (Figure 9). This near neighbor was a city of over 8,000 when the range was discovered, and had a population of 12,071 in 1940.

Yet the location of Crosby and Ironton, close to the area of present-day mining activity, is favorable, compared to that of Trommald (population 166) and Manganese (population 62). These two villages served the underground mines, which produced black manganese ores, and today they are reduced almost to ghost towns (Figure 10). Riverton, dependent entirely on one open-pit mine, is in but little better circumstances.

The present war in Europe, and the defense program in the United States have already had an appreciable effect on the Cuyuna mining activities. Mining has been resumed in one open-pit mine which has been inactive for some years and, coincident with a general increase in production in the Lake Superior District, shipments from the Cuyuna, chiefly of brown manganiferous ore, have increased sharply. In 1940 they totaled 1,734,176 tons, only a little less than in 1937 (when steel production was stimulated by the P.W.A. program) and more than in any other year since 1930. It is expected that 1941 production will be considerably greater, perhaps approaching that of 1929, the range's peak year.

It is possible that there may be a repetition of the first war-time boom in the mining of the black manganiferous ores found in the area north of Trommald. As in 1914, the United States is still chiefly dependent on foreign sources for its manganese. In 1939, the last year of normal commerce, imports of ferromanganese itself, chiefly from Norway, supplied 10 per cent of our needs, and ferromanganese produced in the United States from imported ores supplied 85 per cent. Domestic production

from domestic ores thus furnished only 5 per cent of our ferromanganese. (U. S. Bur. Mines, *Minerals Yearbook, 1940*, p. 582.) Imports of ore came chiefly from Gold Coast (38 per cent of total imports, by manganese content), Russia (21 per cent) Cuba (16 per cent), British India (14 per cent), Brazil (6 per cent), and Union of South Africa (3 per cent). (U. S. Dept. Commerce, *Foreign Commerce and Navigation of U. S., 1939*, p. 211.)

The effect of war upon this trade has been less than might be expected. Imports of ferromanganese have been cut off almost entirely, and shipments of ore from Russia ceased abruptly in the summer of 1940. But imports of ore from other producers have continued at an exceptionally high level, and entries from Brazil and Cuba have increased considerably. (U. S. Tariff Comm., *War and Its Effect on U. S. Imports*, Vol. I, pp. 74, 79, 1940.) Both governmental agencies and private industry have been accumulating reserves, and on May 26, 1941 the Office of Production was able to state that the manganese stockpile was adequate for sixteen months' needs. (*Engineering and Mining Journal*, June, 1941, p. 33.) In view of these facts, general revival of activity among the Cuyuna mines which could produce the black ferruginous manganese ores, seems less than certain, although still not unlikely. Shipments from the Merritt Mine, the only one of this group active, were greater in 1940 than in any earlier year of its history.

It is possible, however, that the Cuyuna Range will furnish more valuable material than the black, spiegel-grade ores. There exists, on the North Range, in association with these ores, a very large tonnage of material which contains about 10 per cent manganese, 32 per cent iron, and 27 per cent silica.

FIGURE 10.—The business section of the village of Trommald, which grew up to serve the mines producing black ferruginous manganese ores, and is now almost a ghost town. Note the overgrown sidewalks, and the grass growing, literally, in the street.

This is not ore, in the accepted sense, because of the high silica content which makes it unmerchantable. It is better termed protore, for it is really the unenriched iron formation, and there are pockets within it where leaching of the silica has left salable black ore.

The mixture of manganese and other minerals in this protore is so intimate that all attempts to separate the various constituents by mechanical means have failed. By chemical treatment, however, a concentrate similar in composition to high grade ferromanganese ore can be produced from this material. Engineering estimates indicate that a plant capable of producing around 10 per cent of our normal consumption of ferro-grade ore could be built at a cost of around $4,600,000. Reserves of the high-silica protore, worthless for other purposes, are adequate for many years' operation of a plant of several times this capacity.

The cost of producing ferromanganese ore in this way would be fairly high, however—nearly twice as great as the New York selling price of foreign ores (including duty) at the beginning of 1939, and well above the average cost of imported ores in any year between 1918 and 1940. (E. W. Davis and C. V. Firth, *Ferro-Grade Manganese Ore from the Cuyuna Range*, Univ. of Minn. Mines Exp. Sta., pp. 1–19, 32–35, 1940. This report was prepared at the request of the Consultant on Manganese for the

Advisory Commission to the Council of National Defense.)

It is clear that under normal peacetime conditions, ferro-grade ore cannot be obtained, at a profit, from the Cuyuna deposits. But the obvious advantages of substantially increasing the almost negligible domestic production of this vital strategic material has led to suggestions that the government should subsidize the working of submarginal domestic deposits. This argument has been reinforced by war-time shipping difficulties, which caused in the spring of 1940 a sharp rise in the price of manganese ore; it now stands at a higher level than it has since the First World War. If domestic production of manganese ore is to be encouraged by the government, the Cuyuna Range deposits offer an excellent opportunity for development, and so may play an important part in the national defense program.

POTATO FED SWINE IN GERMANY

Earl Shaw

FOR the last few years a great deal has been said about Germany's ability or lack of ability to survive the British blockade. Some war strategists think that Britain may achieve success in her venture, and others believe that she will fail. One of the best arguments for the latter group is the enormous potato crop which is raised year after year in the Nazi country—a crop which not only furnishes food directly in large quantities for the German people, but also provides from forty to fifty per cent of the ration for Germany's millions of swine; and these hogs contribute sixty-five per cent of the meat (eighty pounds per capita in 1938), and a large per cent of the fats available for German consumption.

Readers of ECONOMIC GEOGRAPHY may recall former articles by the author on swine production in the Corn Belt of the United States, dairy by-product swine production in Denmark, scavenger hog feeding in China, mast feeding of pigs in European and American forests, all emphasizing a different method of feeding swine which provide a large fraction of the world's meat diet. An examination of Germany's pork industry offers opportunity to study another type of hog feeding contrasting significantly with those analyzed in previously published articles.

POTATO PRODUCTION AS RELATED TO GERMANY'S PHYSICAL GEOGRAPHY

The optimum climate for growing potatoes, which form the dominant item in Germany's hog rations, differs from that ideal for corn, the main food for swine in the Corn Belt of the United States. Many authorities place the poleward limit of commercial maize production in the United States along the boundary of the seventy degree isotherm for the three summer months, a boundary limiting a region with temperatures above the optimum for the tuber crop indigenous to the cool lands of the Andean Highlands. The three warmest months for Konigsberg, East Prussia, in an important region of German potato and swine production, average eleven degrees lower than the summer months of Des Moines, Iowa, in the heart of the American Corn Belt (62 to 73 degrees F. for June, July, and August. Figure 2). It may well be stressed that cool temperatures like those for East Prussia encourage large yields of high quality potatoes. Anyone who has seen the size and quality of carefully produced potatoes on the Andean Highlands and compared them with those raised on the hot humid tropical lowlands will recall that such a comparison is analagous to that of a good sized apple with a medium sized marble. And much of this disparity in size is a result of temperature differences.

The precipitation of East Prussia differs significantly in amount, but only slightly in distribution from that of Des Moines. The German province has fifty per cent less rainfall than that of the Iowa section of the American Corn Belt, although there is the same tendency for a definite summer maximum. However, the lesser total amount and the fewer inches in the cool summer months of the North European Plain are proportionately more efficient than the heavier June, July, and August rainfall

in the hot period of the United States Corn Belt (Konigsberg total 20.5 in., Des Moines total 31.9 in.; Konigsberg, three summer months 8.6 in., Des Moines, three summer months 11.8 in.).

Nazi potato soils are of glacial origin just as those of Iowa, but they do not possess the natural fertility of the Corn Belt prairie-erths and chernozems. The Pleistocene ice sheet was not as kind to the lands of the North German Plain as to the farms of the American Midwest, but the European ice sheet did contribute fair soil structure and other qualities encouraging favorable growth and root expansion of tuber crops.

Thus with an environment characterized by cool moist summers and podsolic soils enriched by fertilizer, the Germans raise more potatoes than any other country in the world on 15 per cent of their cultivable land. And after about half of these potatoes are fed to hogs, there are still enough left for four times the per capita consumption in the United States, for significant quantities of potato flour and alcohol, and for the rumored manufacture of ersatz rubber.

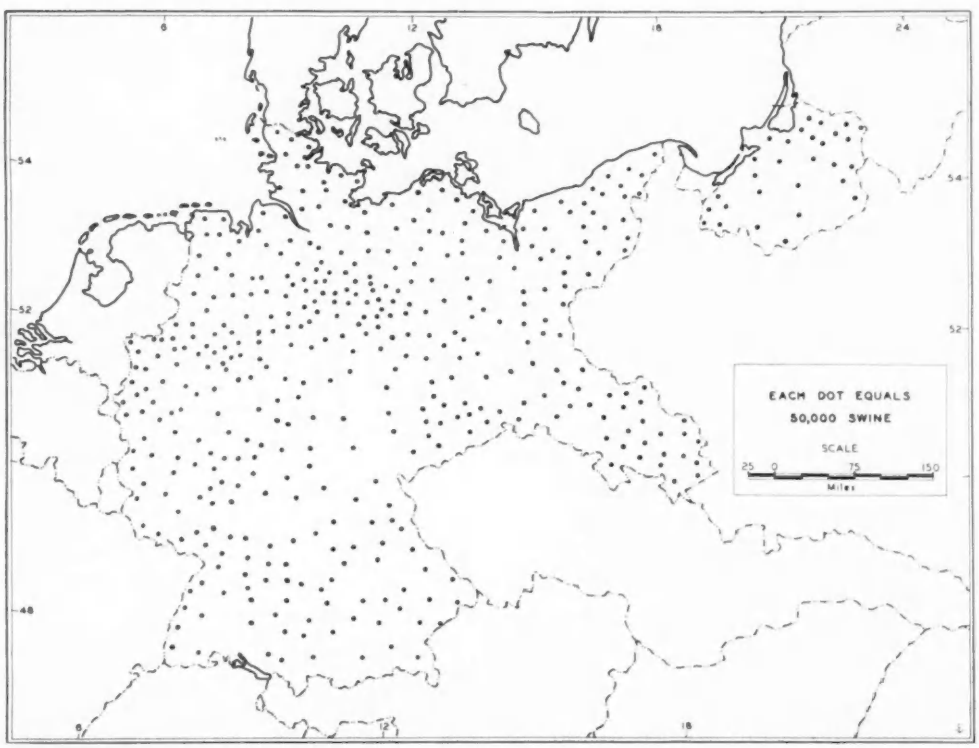

FIGURE 1.—The above map is based on 1936 provincial figures, the most recent detailed statistics available. (Statistisches, Jahrbuch fur das Deutsche Reich, 1937, p. 112, Berlin.) Number of dots is true as to provinces, but actual location of dots may not be accurate, since such exact information could not be obtained. The map shows a relatively even distribution throughout the whole of Germany. Heavier concentration appears on the North German Plain and the foothill regions adjoining. Dense spacing may be noted in Westphalia and the Rhine provinces, where, prior to the present war, the best pork of Germany was fattened, largely on imported feeds. If the swine production figures have been maintained in these regions it is likely that potatoes form a far more dominant ration than they did in 1936. Relatively wide spacing of dots appears in Schleswig-Holstein; if dots were shown for the Danish provinces to the north they would be much closer than those of the adjoining Reich because of the more intensive dairy by-product hog feeding of the Danes. The rugged lands of the Thuringia region show lower than average production. (Location of dots on map through courtesy of Dr. Van Valkenburg.)

PRACTICES IN FEEDING POTATOES TO SWINE

In Germany, as well as in most other large European potato producing areas, potatoes are not fed to swine in the raw state, but go through a process of cooking or steaming before they are offered to hogs. Cooked potatoes make more palatable food for pigs than raw ones and produce cheaper and faster gains. German, English, and American agricultural experiment stations all show the advantage of this type of preparation for the swine ration. A few specific examples will illustrate the importance of this advantage; and since detailed statistics on potato feeding are at present more easily available from American and English sources, much of the information following comes from such references.

During the early 1930's the Agricultural Experiment Station at Pullman, Washington made several tests to determine the comparative value of raw and cooked potatoes for feeding swine. (The Forty-Third Annual Report of the State College of Washington Agricultural Experiment Station, Pullman, Washington, for the Fiscal Year Ending June 30, 1933, Bulletin 291, January 1934, p. 20.) The results showed: (1) that animals fed a ration with a major element of steamed potatoes ate approximately twenty per cent less feed than those rationed with a major element of raw potatoes to make the same amount of gain; (2) that swine eating steamed potatoes made a gain over twice as rapid as that of hogs fed on raw tubers—the exact figures in one test showed a gain of 1.9 pounds per pig per day against .81 pound per pig per day; and (3) that swine relish steamed potatoes more than raw ones—specific results in one case showed that pigs eating from a self-feeder containing raw potatoes ate but one pound per pig per day, while swine self-fed with cooked potatoes ate 2.38 pounds per head per day.

A feeding test in England adds addi-

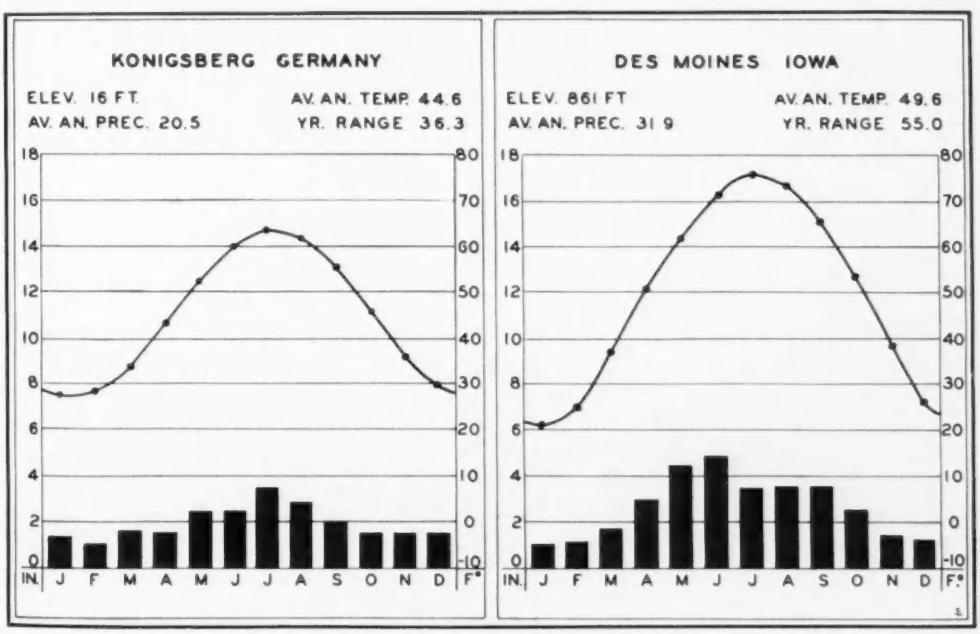

FIGURE 2.—Statistics from Kendrew, W. G., "Climates of the Continents," Oxford University Press, pp. 294, 299; and from Bulletin W.

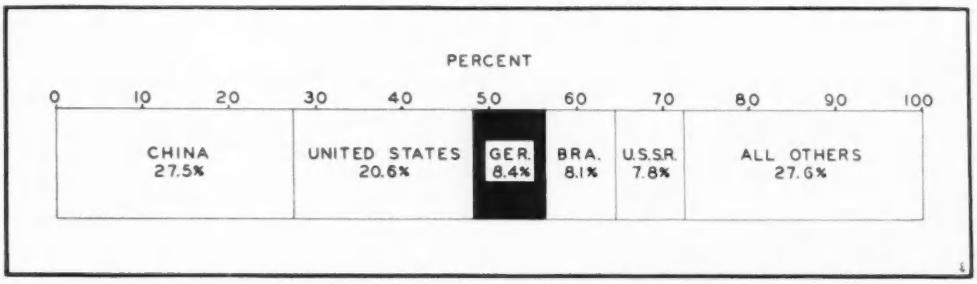

FIGURE 3.—World swine production in percentages. Statistics from Foreign Crops and Markets, Vol. 42, No. 9, March 3, 1941, pp. 290–294. Last available year used for each country, China, 1936; United States, 1940; Germany, 1940; Brazil, 1938; Russia, 1937; and all others 1931–35 average.

tional proof to that of the Washington experiments. The test was made by J. K. Thompson and J. Hargrave at the Agricultural Institute of Kirton in Lincolnshire, England, in 1934. (Journal of the Ministry of Agriculture, Vol. 42, pp. 1123–1127.) The test, like that of the one at Pullman, was made to determine relative values of cooked and raw potatoes for swine food. Results were similar to those of the United States station. Pigs with steamed potato feed took the lead at once over animals eating raw potatoes; furthermore they increased their advantage as the trial proceeded and made cheaper and faster gains on less feed.

While final results of all experiments show definite advantage for cooked potato feed, it should be mentioned that there is a slight expense involved in labor, fuel, and equipment for steaming potatoes and that a shrinkage in weight occurs of approximately 10 per cent.

A comparison of potatoes with cereals for hog feed may interest the reader more than relative values of cooked and raw potatoes. At the Kirton Experiment Station in Lincolnshire, England, steamed potatoes are valued as high as 3¼ pounds for one pound of grains, and the experiments held at Pullman, Washington, show one pound of cereal concentrates equal to 3.86 pounds of steamed potatoes. German farmers consider four pounds of potatoes equal in food value to one pound of cereals.

These figures alone indicate a definite advantage for the use of grains as feed for swine. But the true picture is not seen until comparison of yields per acre is made. In a recent year average German production of potatoes was nearly 300 bushels per acre (284.8 bushels in 1938). In 1938 the average harvest of wheat in the United States was 13.3 bushels per acre; in the same year the average yield of corn in Iowa, a leading corn producing state of the American Corn Belt, was 45 bushels per acre. Thus German potato production is 21 times that of United States wheat per acre and 6 times that of Iowa's per-acre-yield of corn. According to the United States Department of Agriculture, wheat flour possesses fuel value of 1,675 calories per pound, corn meal 1,635 calories per pound, and potatoes only 295 calories per pound. Even with the much lower calory content, high yield of potatoes in Germany gives them a favorable position among major swine feeds of the world.

As the harvest of potatoes in Germany is seasonal, farmers in the country which prior to World War II produced one-fourth of the world's potatoes, must make arrangements for storing this hog feed in the season of plenty for the unproductive winter period. On many

farms silos are used and the number of such storage facilities is constantly increasing. In silage preparation, potatoes are given cooking similar to that characteristic of the tuber ration picked and fed direct from the field. They are usually washed thoroughly and steamed for about forty-five minutes or until they are well cooked. Immediately after they are taken from the steamer, the potatoes are mashed and packed tightly together while still hot, and the air is completely exuded from the mass. Silage is then covered with wet sacks or similar protection and these in turn are covered with a heavy layer of soil, well tamped down.

A detailed description of one type of pit silo follows: a trench is dug four feet deep with slightly oblique walls approximately parallel; width of pit at the top is about five feet and at the bottom four feet. Each side wall is covered with flat sheet iron surrounded by straw and supported by three by four inch posts approximately six feet long sunk obliquely into the ground. When potatoes are put into such a silo, a period of two to four weeks should elapse before the material is fed to swine. A shrinkage of about five and one-half per cent takes place during the storage period besides the ten per cent resulting from steaming in preparation for storage. Silage steamed potatoes are said to have a food value equal to that of the fresh steamed product.

Besides the use of pit silos for steamed potatoes, farmers may store the raw product in caves or cover piles of the new crop with sufficient dirt to protect it from freezing winter temperatures. In some cases the potato harvest is taken to artificial driers where dried or flaked potatoes are prepared for swine. Although tubers prepared in this way have a slightly higher food value, cost of drying may discourage preparation of such a swine ration. Potato pulp, which is the residue from the manufacture of potato starch, does not make pig feed on par with steamed or dried potatoes.

Representative rations for fattening hogs which are recommended by experiment stations in Germany and which are used with certain variations by hog feeders include the following:

1. Fish meal to the amount of two-thirds pound per head per day together with all potatoes animals will eat.
2. The well-known Lehman ration specifies two and two-tenths pounds of a mixture (70 per cent cereals, often rye, and 30 per cent protein concentrates, often 20 per cent meat meal and 10 per cent fish meal) per head per day supplemented by potatoes to the amount animals desire. Pigs weighing a hundred and fifty pounds or more will usually eat at least 14 pounds of potatoes daily. As potatoes do not constitute a satisfactory food for young pigs, only the basal ration of cereals and protein is given until appetites exceed two and two-tenths pounds of concentrates—often at the age of twelve to fourteen weeks.
3. Frolich and Luthge recommend a ration quite similar to the first listed: fish meal to the amount of two-thirds pound, one-tenth pound of soya bean meal and one-third pound of rye per head per day together with all the potatoes pigs will eat.

Prior to World War II, certain sections of Germany used far fewer potatoes in the swine ration than recommended in the three representative feeding formulae listed above. For example the region around Bremen and Hamburg and other sections of northwest Germany raised practically all hogs on grains, together with fish and meat

meal, much of which was imported from abroad. Location with respect to an easy import market made this section, northwest Germany, one of the greatest swine producing regions of The Reich. Since the beginning of the last war, swine raising based on imported feed has declined and greatest pork production has shifted eastward where farming operations are on a larger scale with potatoes and grain the principal crops. Even in the east a lesser proportion of cereals and proteins supplement the main potato ration. In fact due to restricted imports of grain brought about by the British blockade, high tariffs, fixed rye prices, and large potato crops it is probable that potatoes now make up well over half the food value in the swine ration throughout the whole of Germany.

As previously indicated, rations with a dominant potato element should not be given to pigs before they are a few months old. Besides being unsuited for young pigs, experiment stations state that heavy feeding of tubers is inadvisable for suckling sows and for sows well along in pregnancy. Furthermore, overfeeding of potatoes may produce an animal without the bloom of a well finished hog and may develop a pot or thin belly. A few authorities have indicated that feeding potatoes to excess may cause soft fat, not through specific effect of the potatoes, but because of a slower rate of growth. In short best results from a major potato ration accrue, like best results from a major corn ration, when the dominant element is supplemented with the proper proportions of minor balancing items, and when all are fed in correct amounts to animals of proper age and condition.

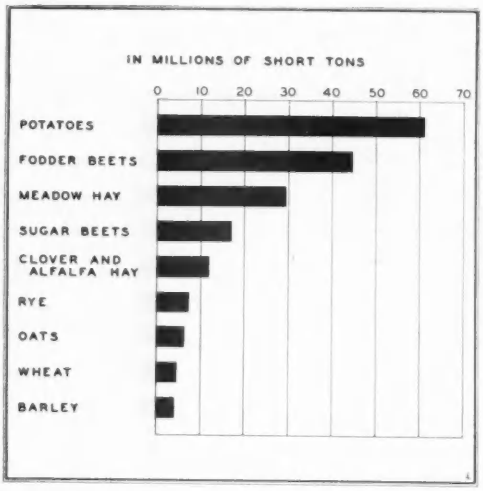

FIGURE 4.—Principal crops produced in Germany, 1937. Statistics from Foreign Agriculture, Vol. IV, No. 4, April, 1940, p. 200. Notice the high standing of potatoes.

BREEDS AND TYPES OF HOGS

German pork eaters have always demanded a hog with more fat than that desired by Danish or English markets. Whether this demand is influenced by the more continental climate of The Reich when compared with that of England and Denmark can hardly be ascertained, but some geographers might suggest the significance of the climatic factor. Probably more important is the fact that Germany has for years lacked self-sufficiency in fats and oils. Before the second world war and the period immediately preceding, easily available vegetable and marine oils at low prices permitted significant contributions to German fat requirements from abroad. During this period German demand for hogs with more meat and less fat was noticeable. Now with many world markets closed to The Reich, the emphasis on the lard hog is, and will continue to be, more pronounced.

The development of pure breeds of hogs has paralleled progress of the German swine industry. Breeders and livestock shows have not been strongly influenced by fads and fancies, and pure bred hog production is a business not a hobby. Just as in Denmark, the aim

has been to produce an animal which would impart to its offspring characteristics of commercial value, and little attention has been given to the perfection of nonessential characteristics. This aim has been attained to a high degree. Pedigrees go back about a half century and since about 1926 records of performance have been filed which are similar to those kept by Danish and Swedish breeders. It is now possible for pedigrees to show fecundity and milk producing quality of a particular strain for three or four generations.

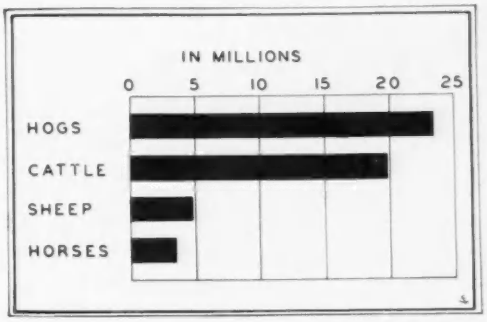

FIGURE 5.—Livestock numbers in Germany, 1938. Statistics from Foreign Agriculture, Vol. IV, No. 4, April, 1940, p. 201. Notice the high standing of swine.

Practically all hogs in Germany are white. There are several breeds, but only two are important. The Edelschwein, which is the English Yorkshire, improved and adapted to German conditions, and the Veredelte Landschwein, which is a native hog improved by selection and crossing, predominate. In a recent year these breeds accounted for 25.6 and 67.3 per cent respectively of all the pure-bred swine recorded in Germany. Hog producers in The Reich recognize the set of the ears as the principal difference in the two breeds. The Edelschwein is somewhat shorter in conformation, has more quality, and the texture of the meat is more desirable. The Veredelte Landschwein is slightly longer in body, hardier, and more prolific than the Edelschwein. Experiment stations find no significant differences in the two breeds with respect to consumption and utilization of feed, rate of gain, or per cent of dressing. The influence of these two breeds is evident in over 90 per cent of the hogs marketed in Germany.

CYCLICAL AND SEASONAL PRODUCTION TRENDS

The hog production cycle in The Reich, according to a leading German authority, averaged about three and one-half to four years before the war and was affected by influences similar to those which affect the hog cycle in other important hog producing countries. A review of the United States Corn Belt cycle may be instructive. After one or two years of bumper corn crops, low prices for grain are likely to follow. The farmer hesitates to part with his corn at low figures and breeds more sows which provide an outlet for the corn and remove much of the surplus grain from the market. But in time the increase in swine lowers the price of pork just as it paves the way for higher corn prices. Higher corn prices may also be aided by drought or frost conditions. At any rate the higher grain prices and low pig market discourage further swine feeding. The farmer decides to breed fewer sows and to sell his corn, a general policy which will soon bring about lower grain prices and higher market for pork.

The German hog and potato cycle reacted much the same way when unaffected by war conditions. Now government price control of farm prices in both the United States and Germany interferes with the natural swings in the animal and animal feed cycle.

Seasonal production of pigs is similar to that followed in the United States Corn Belt. A system of raising two litters a year is practiced, one coming in

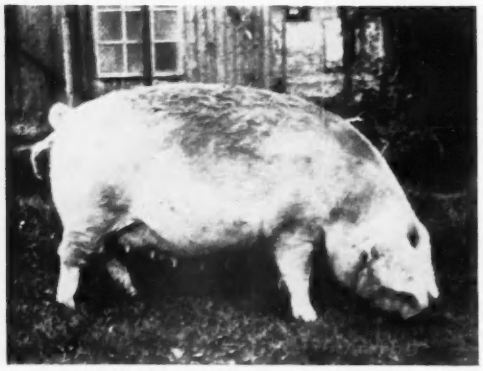

FIGURE 6.—German Landschwein Sow. (After J. Schmidt.)

spring about February and March and the other arriving in fall in September or October. With the potato crop maturing early in autumn, the spring pigs can be finished off with the new harvest for fall or winter market. In the case of fall litters, which are not so numerous as those of spring, storage potatoes are likely to be used for fattening. The lesser number of autumn than spring litters is partly a result of higher feeding costs during the colder winter period when certain extra amounts of feed are needed just to maintain bodily heat. Less feed is necessary for spring litters which have warmer months of summer and fall for making their gains.

Like seasons of farrowing, seasons of marketing show influence of geographic factors. Market receipts increase in fall after crops are harvested. The new harvest permits rapid finishing out of early spring pigs, and peak of sales is reached in winter when the general run of spring farrowed animals has had time for fattening. A gradual decline follows during spring and summer as feed supplies become more or less exhausted. Average weight of market hogs tends to show a similar influence.

PROBLEMS OF SWINE AND POTATO DISEASES

Diseases among swine in Germany are said to be kept at a minimum just as they are among herds of Denmark. Both countries follow an intensive type of hog raising and in both nations pig production is largely a dry lot proposition. About two-thirds of German hogs are owned by farmers who possess less than fifty acres of farm land; and such pasture as is available is needed for cattle. Sows are pastured only to a limited extent and throughout Germany fattening is done on concrete and under cover. One might think that with crowding resulting from this type of swine growing, diseases would be a serious problem. Such is not the case. Reasons are associated with the German reputation for keeping barns, lots, feed troughs—in fact all parts of the swine environment—scrupulously clean. As is well known, cleanliness is a requisite

TABLE I

SWINE PRODUCTION BY PROVINCES IN GERMANY

Name of Province	*Number of Swine*
East Prussia	1,625,157
City of Berlin	27,864
Brandenburg	1,411,473
Pomerania	1,625,674
Grenzmark and West Posen	258,012
Lower Silesia	1,065,722
Upper Silesia	587,634
Prussian Saxony	1,602,381
Schleswig-Holstein	831,356
Hanover	2,899,123
Westphalia	1,599,963
Hessen-Nassau	816,789
Rhine Province	1,013,311
Hohenzollern Land	34,733
Prussia	15,399,192
Bavaria	2,450,069
Saxony	811,080
Wurttemberg	696,763
Baden	563,753
Thuringen	583,531
Hessen	374,676
Hamburg	16,057
Mecklenburg	736,631
Oldenburg	506,385
Brunswick	219,354
Bremen	13,729
Anhalt	108,158
Lippe	135,144
Lubeck	13,070
Schaumburg-Lippe	54,184
Saarland	101,300
Total	22,783,076

(Statistics from *Statistisches, Jahrbuch, fur das Deutsche Reich*, 1937, Berlin, 1937, p. 112.)

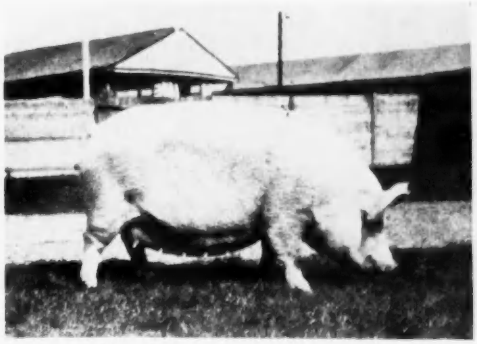

FIGURE 7.—German Edelschwein Sow. (After J. Schmidt.)

to easy disease control and Germans and Danes have mastered this requisite.

Since diseases and insect pests attacking potato crops may vitally affect swine production by limiting feed, a word on that subject seems advisable. In 1940 the potato beetle became a serious menace to Germany's most important food crop, and the fight against it took the aspect of a national crusade. Periodical search of fields developed with large numbers of farm workers and school children gathering and destroying the pests. All necessary insecticides and utensils required for applying them were supplied free to farmers by local government authorities. Destruction of beetles was accomplished without serious damage, although at the expense of great effort. Interest was added by German reports that the R.A.F. was trying to limit potato production and swine feed dependent upon it by dropping showers of beetles on fields from the air. Certain German scientists with favorable records in chemical research are seeking specific chemical agents to prevent development of the beetle pest, with results so far unsatisfactory; other scientists have been working on new types of potato plants resistant to ravages of beetles and also are trying to discover parasites harmless to potato plants that would prey on the beetle.

TABLE II

POTATO PRODUCTION BY PROVINCES IN GERMANY

Name of Province	*Hectares Producing Potatoes*
East Prussia	161,711
City of Berlin	1,850
Brandenburg	316,788
Pomerania	254,443
Grenzmark and West Posen	71,029
Lower Silesia	205,475
Upper Silesia	92,291
Prussian Saxony	220,978
Schleswig-Holstein	32,207
Hanover	190,174
Westphalia	92,548
Hessen-Nassau	89,891
Rhine Province	138,153
Hohenzollern Land	4,991
Prussia	1,872,529
Bavaria	353,346
Saxony	106,894
Wurttemberg	74,037
Baden	68,015
Thuringen	73,421
Hessen	60,781
Hamburg	604
Mecklenburg	84,994
Oldenburg	26,583
Brunswick	21,892
Bremen	441
Anhalt	19,530
Lippe	7,379
Lubeck	784
Schaumburg-Lippe	2,196
Saarland	19,146
Total	2,792,572

(Statistics from *Statistisches, Jahrbuch, fur das Deutsche Reich*, 1937, Berlin, 1937, p. 89.)

POTATO FEEDING IN OTHER LANDS

While stress has been placed upon German swine production throughout this study, it is well to keep in mind that other sections of the great North European Plain raise large quantities of potatoes and feed an important fraction of them to swine. In parts of Russia, the Baltic States, former Poland, southern Sweden, and the British Isles potato fed hogs are found on many farms.

Very little of this type of hog raising occurs in the United States. In the first place the United States is not the great potato country that Germany is, with production on only one per cent of cultivated area in America while in the German Reich, as was previously indicated, fifteen per cent of the cultivated

land is devoted to the crop. Moreover, the yields in America are lower than those of Germany—in 1938 the figures were 123.1 bushels per acre in the U. S. and 284.8 in The Reich. In fact the whole of North America ranks low in world potato production when compared with Europe, which accounts for between eighty and ninety per cent of the earth's potatoes. A reason just as important in accounting for the limited feeding of potatoes to hogs in the United States is associated with the fact that America is the world's greatest corn producing nation and corn is the feed ideal for hogs. Only when United States potatoes are extremely cheap do farmers even consider feeding them to swine and this situation occurs at rare intervals.

Sweet potatoes are raised in quantity in our Southland, but as in the case of the so-called Irish potatoes, the sweet varieties are seldom fed to swine. Only when a huge surplus hangs over the market do feeders attempt to turn them to swine feed; and times when feeding costs compare favorably with those of corn are infrequent.

Just as few potato fed swine are found in the United States, so few are encountered in other countries outside Europe. Europe dominates in potato production just as significantly as the United States does in corn; and likewise the Continent attains the same commanding lead in raising potato fed swine that the United States attains in producing corn fed pork.

Some emphasis on swine production other than that based on potato feeding has been evident in Germany and in other European warring nations since the conflict started. War has given impetus to saving all kitchen waste which is used in feeding swine especially in the suburbs of large cities and in large towns. W. A. Stewart, writing in the *Journal of Ministry of Agriculture*, December 1939, Vol. 46, pp. 627–633, states that "it would help materially if pigs could be distributed over as many farms and back yards as possible"—distributed so as to take care no waste develops in household scraps, damaged grain, grass or vegetables. While this practice is much less important than feeding potatoes, it shows the influence of war on increasing methods of production which practically duplicate practices used in Chinese swine raising.

SUMMARY AND CONCLUSIONS

Germany provides an excellent example of swine production based upon a dominant crop, that of potatoes. Climates of the whole North European Plain, of which major sections of Germany form a part, are favorable to potato growing. The German soils are likewise adapted to producing root crops. In fact soils and climate both conspire to make The German Reich the greatest world producer of potatoes and only the farm lands of Eire account for higher per acre yields—310 bushels per acre to 285 bushels in 1938.

German potatoes, with certain supplementary items, form a swine ration capable of producing hogs which compare favorably with those grown in other large pork producing countries. But the preparation of the potato ration is different from that of swine rations in other lands with pork production based on a dominant crop. For example, in the Corn Belt of the United States corn, the major element of the hog's ration, is fed in the raw state, either on the cob or shelled. Again, in Denmark skim milk or buttermilk is given to the pigs just as it comes from the creamery or mixed with some concentrate. But in Germany, where

potatoes make up much of the swine food, the tubers are cooked before they are placed in feeding troughs.

In feeding cooked potatoes to swine, the German farmer has found that it takes from three to four pounds of steamed tubers to equal the food value of cereal concentrates; but this situation does not put the potato in a bad light since an acre of land may produce six to twenty times as many pounds of potatoes as cereals. As the production of potatoes is seasonal, many are stored in pit silos for winter feeding throughout The Reich. Most potatoes are cooked before going into storage.

The shortage of fats encourages the production of hogs which will contribute as much lard as possible. The Edelschwein and the Veredelte Landschwein breeds, which make up most of the German hogs, cannot be classed as pure lard types, but are fed to produce the ultimate amount of fat. Just as in Denmark, the aim of most German hog raisers is to produce animals which will impart to offspring characteristics of greatest commercial value—characteristics such as high fecundity and high milk producing qualities.

Hog raising and potato growing in Germany go through price and production cycles similar to those characteristic of corn and hogs in the United States Corn Belt. Cyclical tendencies in both regions are interrupted when government control takes a hand. Seasonal differences are current in both production and marketing of swine.

Cleanliness of buildings and lots limits the disease hazard among German swine and scientific research is constantly alert to limit similar problems in the potato fields.

Although sections of Germany, especially the Northwest, used large quantities of imported swine feed prior to World War II, the British blockade and other influences have limited such feeding practices in recent years. At present potato producing areas and swine producing sections probably correlate more closely than ever before.

Swine raising based upon potato feeding is likely to continue its present high place in German agriculture. When peace comes Germany may add more proteins to the dominant potato ration for swine by increasing her dairy industry and thus placing more dairy by-products such as skim milk and buttermilk in the swine troughs. Right now, however, it is doubtful that farmers are allowed to feed any milk products to swine. Corn offers little competition to the present swine ration dominated by potatoes, for the German climate and soils are not suitable for commercial maize production. Finally, mast feeding another well-known method of raising hogs is not likely to displace potato feeding. Some may think that Germany's hogs could be fed in her vast beech and oak forests where roots, insects, worms, beechnuts, and acorns are available. But this extensive type of hog production has no important place in densely populated Germany's intensive system of agriculture, a most important phase of which is raising potatoes for man and his greatest meat producer, the hog.

POPULATION CHANGES IN A MOUNTAIN COUNTY

Ronald L. Ives

FIELD and statistical studies in the Colorado headwaters area, west of the Continental Divide in north-central Colorado, disclose that the population, from the time of the first settlements until about 1900, increased gradually, at the declining rate characteristic of a frontier area that is "filling up." Since that time, the population has more than quadrupled, but at an extremely erratic rate, almost wholly due to migration. Despite numerous local beliefs concerning reproduction and death rates, these changes in population most closely correlate with nation-wide economic conditions.

Introduction

Grand County, Colorado, containing several major sources of the Colorado River, notably the Colorado, the Fraser, and the Blue, is located just west of the Continental Divide in the northern part of the state. Relation of Grand County to the major drainage features of Colorado is shown in Figure 1. The political division, Grand County, is largely coextensive with the physiographic basin locally known as Middle Park.

Grand County, with an area of 1,866 square miles, has a maximum relief of nearly 7,000 feet, the lowest point being the bed of the Colorado River at the Grand–Eagle County line, 6,800 feet above sea level; the highest point being disputable, but well over 13,500 feet above sea level. Mean elevation of Grand County is in the neighborhood of 9,000 feet, exact determination not being possible because of lack of accurate maps. The county is a series of flat-floored basins, separated by rough uplands, and surrounded in large part by high mountain ranges. The basin floors, on which are located the principal settlements and ranches, are at elevations between 7,000 and 9,000 feet above sea level. All areas above 10,000 feet are substantially uninhabited, and practically uninhabitable for nine or more months of the year. A typical basin area—Stillwater Basin—north of Granby, is shown in Figure 2. The only thorough topographic description of Grand County is that of Marvine. (Marvine, A. R., *Report of Arch R. Marvine, Assistant Geologist Directing the Middle Park Division*, U. S. Geol. Survey Terr. 1873.)

The climate of the area is characterized by extremes, both annual and diurnal due not only to high altitude, but to the accentuation of daily convections as a result of the great topographic relief. This local weather has a great influence on local activities. (Ives, R. L. "Weather Phenomena of the Colorado Rockies," *Journ. Franklin Inst.*, Vol. 226, 1938, pp. 691–755. "Colorado Front Range Crest Clouds and Related Phenomena," *Geog. Rev.*, Vol. 31, 1941, pp. 23–45.)

Local industries are ranching, high-altitude truck farming, forest work, tourism, and mining. All of these occupations are distinctly seasonal, so that most Grand County residents are, of necessity, extremely versatile. Although nearly every quarter-section of Grand County shows some trace of mineralization, mining is seldom profitable, and few carloads of ore from this area have

paid enough to cover freighting costs. Traces of oil are also present, and several promising structures have been mapped, but holes drilled to date have merely shown where the oil was not. (Lovering, T. S. "The Granby Anticline," *U. S. Geol. Survey Bull. 822*, 1931, pp. 71–76.)

FIGURE 1.—Outline map of Colorado, showing location of Grand County (shaded) and principal drainage features.

POPULATION FIGURES

The population of Grand County from 1880 to 1940, as given by census figures for the plotted decennia, is shown in Figure 3. For purposes of comparison, the populations of Colorado and of the United States are shown to a different scale in this figure.

Prior to 1880, Grand County was larger than at present, and so unorganized that computation of the number of inhabitants in the present county area would be meaningless. (Hall, F. R. *History of the State of Colorado*, Chicago, 1895, Vol. IV, pp. 136–143.) Many of the early records were destroyed in the violent county-seat wars of the early 1880's. Field studies indicate the existence, prior to about 1890, of a number of rather large settlements in Grand County, of which no record can be found today. These, mining and lumbering camps, were occupied for some time, but were apparently abandoned very suddenly when "the ore ran out" or the timber was all cut.

Prior to 1900, the population growth of Grand County, as a result of natural increases and immigration, was in general accord with that of the state of Colorado, and showed indications of stabilization at a figure about .001 that of the state. This period will be called the Pioneer Phase.

After 1900, the population of Grand County fluctuated quite rapidly, and subsequent census figures give no indication of the true present trend, other than erratically upward, or of the eventual population ceiling. As this phase of growth roughly coincides with the coming of the railroad to the area, it will be called the Railroad Phase.

Soon, with the completion of the Colorado–Big Thompson Transmountain Diversion Project, the Railroad Phase will be ended, and an entirely new and different phase, with unpredictable population and economic effects will begin.

This investigation is largely concerned with the causes of the rapid changes in the population of Grand County during the Railroad Phase, a time when economic conditions within the county were not only good but steadily improving.

Although census and other population figures from Grand County leave much to be desired, enough data are available so that derived figures will be within reason, and conclusions drawn from them at least substantially accurate.

PIONEER PHASE

From 1860 to 1900, Grand County was in process of organization and settlement, and suffered from the usual series of mining booms, Indian troubles, range wars, county-seat wars, and outlaw disturbances characteristic of western areas. By 1900, these various

troubles were solved, and the future of Grand County seemed to be one of ranching and desultory mining, with a small amount of timber production as a seasonal sideline.

During the pioneer phase, population of Grand County increased from an unknown, but small, figure (a few fur-trappers, fugitives from justice, and religious fanatics lived there prior to 1860) to about 741, as shown by the census of 1900. Indian population is not here considered. Population increases for decennia ending each decade from 1890 to 1940 are shown in Figure 4. These increases are obtained by subtracting from the total population at the end of a decade that at its beginning, data being obtained from census reports.

It will be noted, from reference to Figures 3 and 4, that the population curve was definitely flattening by 1900, and that, under conditions prevalent in that year, an ultimate figure of about 1,000 would be reached. This flattening is in large part due to occupation of all desirable lands in the county.

Breakdown of these increase figures into natural increase and migration was found to be difficult, due to absence of records in Grand County. Birth and death, among pioneer people, are regarded as natural phenomena, like the weather, and are recorded only when there is something unusual about them.

FIGURE 2.—Stillwater Basin, Grand County, Colorado, as seen from the southwest. The high peaks forming the horizon are part of the Front Range. In the foreground are the first irrigated ranch lands from which large hay crops are annually produced.

Further complicating this breakdown is the great, but decreasing, excess of males over females in Grand County, shown by every census from 1880 to 1940. Because of this shifting sex ratio, shown in Figure 5, birth rates cannot well be assumed on the basis of total population, but figures within reason may be obtained on the basis of births per 100 females per decennium in Colorado (53, 1900), birth records for Grand County being entirely inadequate. By multiplying the average number of females in Grand County by this figure, the approximate number of births in Grand County is arrived at. This figure should be within reason, but probably is not rigorously accurate, for in a frontier area, where a large male excess is characteristic, an appreciable percentage (although a small number) of the women do not marry. Of these, a few will be school teachers, who, in many instances, are not interested in marriage. Others will be prostitutes, who avoid childbearing for professional reasons. Some of the others will be spinsters by choice or circumstances beyond their control. As the male excess decreases, the number of unmarried women will tend to increase at a much slower rate than the rest of the female population; there still being one school teacher and one prostitute in each small settlement.

The death rate, which affects the entire population, is likewise not accurately recorded during this pioneer phase, and it is assumed that the Grand County death rate was similar to that of Colorado in 1900 (14 deaths per 100 population per decennium). Total deaths are computed for the average

population during the decennia considered (1880–1890, 1890–1900). Violent deaths were numerous in the early days of Grand County, but their influence on the death rate is at least partially offset by the absence, from the general population, of persons in precarious health.

Total births and deaths for these intervals, as well as natural increase (births minus deaths) and increase due to migration (total increase minus natural increase), as computed on these bases, are shown in Table I.

TABLE I

INCREASES IN GRAND COUNTY POPULATION FROM 1880 TO 1900

Decade	*Births*	*Deaths*	*Natural Increase*	*Migration*	*Total Increase*
1880–90	75	71	4	+183	187
1890–00	134	87	47	+90	137

Prior to 1880, due to the small number of women in the area, natural increase was negative, and population was maintained only by immigration.

Reference to this table plainly shows that during the interval 1880–1900 a declining rate of population increase was accompanied by an even greater decline in immigration. This seems to be characteristic of a frontier area that is "filling up," and needs no further discussion.

RAILROAD PHASE

Beginning in 1900, and continuing until the present, the population of Grand County fluctuated rapidly, and without any apparent relation to population changes in adjacent areas. As these population changes coincide with, and seem indirectly related to, the coming of the railroad to Grand County, this interval will be called the Railroad Phase.

Population changes during this time are shown in Figure 3, the data being

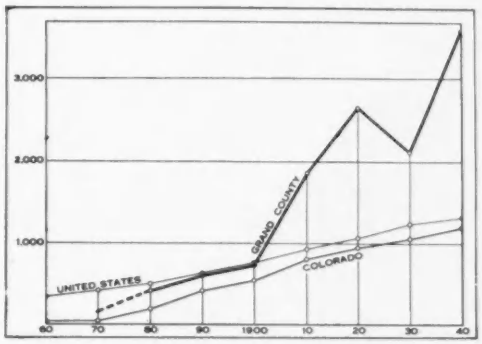

FIGURE 3.—Population of Grand County, Colorado, from 1880 to 1940. Population of Colorado from 1860 to 1940 is shown on a scale of 1: 1,000, and that of the United States for the same period, to a scale of 1: 100,000, for comparison.

obtained from census reports for the respective years. From these, the population gains per decennium, shown in Figure 4, were computed. From other census reports, the population figures were subdivided according to sex, and the male-female ratio computed. This is shown in Figure 5, the 1940 data being obtained from advance estimates by the Census Bureau.

From these data, the population increases (negative in 1930), are broken down into natural increase and migration. Better statistics are available for this interval, and a birth rate based on the actual number of births to Grand County residents (this is *not* the number of births in Grand County) is used for the 1930–1940 decade. A marked drop in the *local* death rate is noted. A breakdown of population increases from 1900 to 1940 is given in Table II.

These figures, derived by simple computation from the best available census data, should be regarded as careful estimates, and may be in error by as much as ten per cent. Even with this error, however, they indicate quite plainly the directions and approximate magnitudes of the changes in the population of Grand County during the last 40 years.

TABLE II

INCREASES IN GRAND COUNTY POPULATION BY NATURAL INCREASE AND MIGRATION

Decade	*Births*	*Deaths*	*Natural Increase*	*Migration*	*Total Increase*
1900–10	262	112	150	971	1121
1910–20	460	198	262	535	797
1920–30	499	147	352	−903	−551
1930–40	570	171	399	1040	1439

A minus (−) sign indicates loss. Colorado birth rate for 1900 (53 births per 100 females per decennium) is used until 1930. Death rates are averages for each decennium, based on figures supplied by the U. S. Census Bureau. Birth rate for the decennium 1930–1940 is that for Grand County in 1938 (47 births per 100 females per decennium: figures from the Colorado bureau of vital statistics) and includes all births to residents of Grand County. In this year there were 33 births to residents within the county, and 28 births to residents of Grand County in other locations, chiefly Denver.

LOCAL CUSTOMS AFFECTING POPULATION FIGURES

Inspection of the above figures indicates that "raw" census figures from Grand County must be used with considerable caution, for the birth rate (uncorrected) is sufficient to maintain the population only if the average length of life is in the neighborhood of 70 years. Death rates in this area, according to census figures, are abnormally low also, and from them it may be erroneously concluded that the average Grand County resident lives about a century and a half.

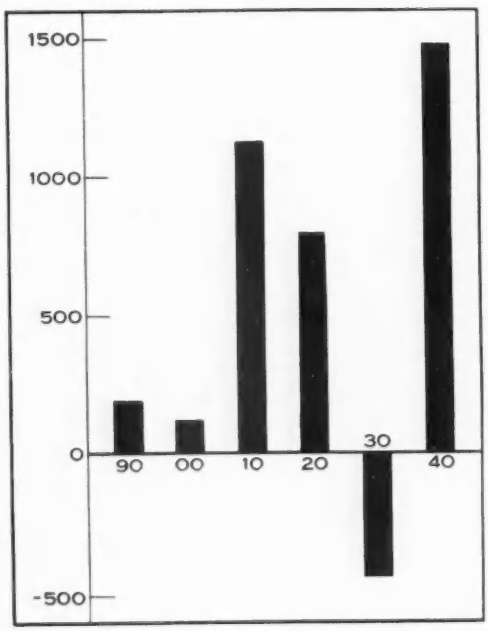

FIGURE 4.—Increases in the population of Grand County for decennia ending in the years 1890 to 1940. A minus (−) sign indicates loss of population.

In contrast to the above, both field observations and census figures show that the population of Grand County is predominantly young; that the median age of the population is below 30 years; and that the number of aged persons in the area is abnormally small.

The low birth rates shown by "raw" census figures immediately rise to somewhat above normal when births occurring to Grand County residents outside of Grand County are considered. Since the coming of "easy" transportation to the area (The Moffat Railroad), all residents who were financially able have gone "outside" (usually to Denver, or some nearby city at a low altitude) for childbirth, operations, and when in ill health. In recent years, over 40 per cent of births to Grand County residents have taken place outside of Grand County. With the recent adoption of the practice of referring births to the place of legal residence of the parents, this discrepancy should disappear.

Many Grand County residents, when approaching the age at which hard outdoor labor is no longer possible, emigrate to either Denver or California, establish legal residence "outside," and in these relatively easy environments live many years. This practice leads to a definitely low Grand County death rate, despite the high altitude, which causes a high incidence of pneumonia and cardiac trouble. As far as can be determined, the life expectancy of a normal human at the altitude of Grand County (above 6,800 feet) is slightly less than at sea level, all other factors remaining the same.

When the total births (local plus referred) per 100 Grand County women in any time interval are compared to those per 100 women in the same interval in more accessible areas in the mountain region and on the adjacent plains, the Grand County rate appears discrepantly high. If, however, the relatively small proportion of Grand County women past childbearing age is considered, and the birth rate per 100 women of childbearing age computed, the rate for Grand County approaches that for other rural areas in the Rocky Mountain region. Due to absence of adequate statistics, an exact figure of this type for Grand County is unobtainable.

CAUSES OF POPULATION CHANGE

The changes in the population figures for Grand County from 1880 to 1940 have been shown by the foregoing figures, and an approximate breakdown of the decennial increases into natural increase and migration has been computed from them.

As far as can be determined from existing figures, the natural increase in the area is slightly above that of the state as a whole, even after adjustment of estimates to take into consideration the emigration of the aged. Remaining to be explained is the complex of factors influencing the amount and direction of migration. It should be noted here that the foregoing computations show only net migration, and that a certain amount of immigration must take place to balance the emigration of the aged.

Pioneer Phase.—From some time before 1860 until about 1875, Grand County was a place of refuge for outlaws, irresponsibles, and religious fanatics, who lived on somewhat amicable terms with the local Indians, and occasionally intermarried with them. These people, who left few records other than abandoned cabins and unmarked graves, broke the trails followed by gold-seekers and settlers. From 1875 until 1900, Grand County was an isolated ranching area, producing little besides cattle, horses, and a few sheep. Transportation costs were prohibitive, and the area, under these conditions, had a probable maximum supporting power of about 1,000 persons. In 1900, when the population of Grand County was 741, and the ratio of males to females 1.6 to 1, this limit was being approached, as is plainly indicated by the decline in immigration, the decreasing male excess, and the growing natural increase. All of these changes, taking place in a frontier area, are indications that it is "filling up." (See Figures 4 and 5, and Table I.)

Railroad Phase.—In 1902, as a direct result of the work of David H. Moffat, the long-projected railroad from Denver was constructed to and across the summit of the Front Range, and the trip from Grand County to markets in Denver was reduced from about four days, over a route seldom passable for more than six months in the year, to about six hours, over a route open for nearly eleven months of the year. Costs of transportation were reduced accordingly, and raising of a number of specialized high-altitude crops (notably "Granby Lettuce") became possible.

Almost before the ballast of the Moffat Railroad had settled, a new wave of settlers was on its way to Grand County. These were not the fugitives, gold-seekers, or adventurers of earlier days, but stable homesteaders who came to work the soil and brought their families along. This is plainly shown in the census figures for the period 1900–1910, when, accompanying a sharp rise in population is a moderate decline in the regional male excess (Figures 4 and 5). Practically all of the available

farmland was occupied before 1915, and the population increase due to a localized "open frontier" became less each year. This is indicated by a falling immigration rate between 1910 and 1920, but the indications must not be taken at face value, because of other factors.

Opening of Rocky Mountain National Park (1915), accompanying expansion of nearby National Forests, road building, and railroad improvements, all attracted to the area a large number of construction and forest workers, most of them either single, or living away from their families. This change is shown by the increased male excess in 1920, a small part of which was due to the return of veterans from the European War. A large percentage of these newcomers were not farmers, and had no intention of settling permanently in Grand County. This was the first major population increase in Grand County that was not directly due to relatively better agricultural conditions in the area.

Between 1920 and 1930, the population of Grand County diminished rapidly (Figure 3). This could be explained quite plausibly as a result of the declining farm incomes of that decade, as is shown by a number of rather convincing estimates. Certainly cash incomes to farmers in Grand County declined during this interval, but this worked little hardship on the established land-owning residents, who obtained subsistence, or a large part of it, from their land, and earned ready money from the growing tourist industry, and from work on the Moffat Tunnel. Despite rather gloomy statistics, actual conditions in Middle Park, as far as settled ranch families were concerned, improved rather steadily from about 1915 to the present. Direct inquiry discloses that the emigrants during the decade 1920–30 were almost entirely those who depended solely upon wages for subsistence. A considerable proportion of these emigrants were single men, most of them unskilled or semi-skilled laborers. That these statements, based on local information, are substantially correct, is shown by the sharp decline in the male excess that accompanied the population decrease between 1920 and 1930. (Figures 3, 4, and 5). So many of these workers were attracted away from Middle Park by the relatively high wages offered at the time by industry that a shortage of labor was noted in Grand County.

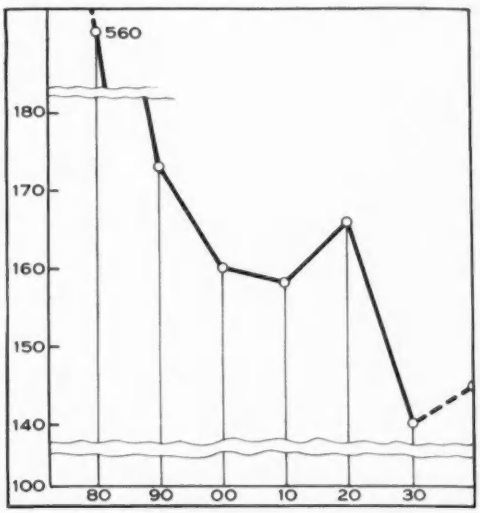

FIGURE 5.—Males per 100 females in Grand County, Colorado, from 1880 to 1940.

During the economic upheavals from 1930 to 1940, the population of Grand County nearly doubled. Immigrants during the early part of this decade were professional and white-collar workers, unable to find employment in the industrial centers, due to the depression. Many of these were able, despite supposedly hopeless economic conditions, to establish small businesses, which, in a surprising number of instances, have become quite profitable.

Later, as a result of changed farm policies, public works programs, the construction of the Dotsero Cutoff (making the Moffat Railroad a through

transcontinental route), and the growth of the tourist industry, numerous unskilled and semi-skilled workers were attracted to Middle Park. Unlike the immigrants between 1910 and 1920, these newcomers brought their families, and planned to stay "as long as the job lasts, and maybe longer." This new trend is plainly shown by the slight increase in the male excess, as shown by preliminary figures, accompanying a great increase in total population.

During this time, the established ranchers, with local markets not only for their cash crops, but new outlets for products that they formerly could not sell because of haulage costs, and an increasing tourist industry, enjoyed improved economic conditions, which were promptly shown by increased retail sales, decreased delinquent taxes, and numerous material improvements to their properties (paint, new fences, telephones, radios, acquisition of high-grade breeding stock, and of new trucks).

It is notable that the population changes in Grand County, prior to about 1915, depended almost solely upon changes in the supporting power of the land; while those after about 1920 can be more closely correlated with the relation of the per capita income (cash plus subsistence) in Grand County to that in other areas; and that the population flow was definitely in the direction of the greatest effective income.

LOCAL BELIEFS REGARDING POPULATION

During the progress of field studies in Grand County, many local beliefs regarding population, and the factors influencing its change, were encountered. Although many of these are out-dated and thoroughly disproved superstitions, a few seem to merit further consideration, because of some evidence in their support.

It is quite commonly believed, in Grand County, that the population is maintained only by immigration, the birth rate being too low to replace losses by death and emigration of the aged. This negative natural increase is blamed on the altitude, which is reputed to cause sterility. Local residents also claim that the intelligence of the general population is declining, because intelligent people, in this environment, are not interested in the opposite sex.

Although the "raw" birth rate for Grand County suggests a decline in population, corrected figures indicate a healthy positive natural increase in the area. Medical evidence discloses that sterility does result from migration to a very high altitude, but the elevation of Grand County is not great enough to cause this. Consultation with several physicians in the area discloses that the principal causes of sterility are metabolic disturbances, due in large part to lack of iodine; and abortions unskillfully performed. Neither of these causes is a direct effect of high altitude.

The large number of unmarried men in Grand County is frequently used as proof of the theory that people in high altitude environments do not marry. With a ratio of 140 males to 100 females, a relatively large number of unmarried men is to be expected.

The reported decline in the intelligence of the general population is, unfortunately, real, and is a result of the isolated high-altitude environment. An appreciable percentage of Middle Park children, on finishing high school, plan to attend college. Of these, the more persistent are able, usually by undergoing many hardships, to obtain the coveted degree. This usually entails four years of extreme overwork, and

semi-starvation. Upon graduation, very few of these ever return to Middle Park, but find work either in the cities of the mountain region, or in eastern industrial centers. With very few exceptions, they become moderately successful, despite the "mining" of their physical resources necessary to obtain a college education.

This loss of the most intelligent and most industrious members of each generation is a serious problem for Grand County to solve. There are at present few opportunities in Grand County for skilled or professional workers, or even for good second-rate typists. Until the area presents something to retain intelligent and skillful workers, this "attrition of intellect" will continue.

Because of the general physical and mental soundness of the Grand County population, there is little danger of the area becoming the home of a large clan of "feeble-minded second cousins."

CONCLUSIONS

The foregoing facts and inferences indicate quite plainly that the population changes in Grand County from 1880 to 1940 have been due almost entirely to economic factors, but that these factors have operated in slightly different ways at different times. The pioneer phase was quite definitely a period of the filling of a frontier area. The earlier years of the Railroad Phase were similarly governed, the population increase at this time being largely due to improved transportation, with a resultant increase in local opportunities. Since about 1920, Grand County has become a sort of population "surge tank," absorbing unskilled and semi-skilled workers when industrial opportunities were few; supplying workers in the same classification (but not necessarily the same individuals) when industrial incomes were more attractive than farm incomes.

Largely uninfluenced by economic conditions has been the steady loss, from Grand County, of the younger residents intellectually capable of becoming skilled and professional workers.

Rough reconnaissances of other geographically-isolated regions suggest that similar factors are influencing the population changes in other areas. Although the vital statistics of most of these areas are either lacking or hopelessly muddled, a study of North Park, Figure 1, adjacent to Middle Park, and geographically similar to it, should be productive.

Note:—In addition to the coöperation given by many residents of Grand County during the progress of field work, and the financial assistance granted by the American Philosophical Society, the writer received much useful information from the United States Census Bureau, and was supplied much useful information by the libraries of the University of Colorado, the University of Texas, Texas Christian University, and the City of Fort Worth.

SKI GEOGRAPHY OF NEW ENGLAND

Albert S. Carlson

THE remarkable growth in the number of skiers in New England has turned the long winter of the uplands and mountains from a liability to an asset in the last few years. During those years a new business has grown into a major industry replete with geographical associations and widely enough distributed to permit of delineation into ski regions. The economic significance of the new industry is most striking when one compares the boarded-up hotels and locked gasoline pumps in nearly every summer vacation town of central and northern New England during the winter months of the 1920's and early '30's with the 198 establishments prepared to lodge 7,320 people in the year 1940–41. Furthermore, the "Skier's Guide to New England," published by the New England Council, lists over 1,000 miles of charted trails, 169 ski tows, 99 ski jumps, and hundreds of open slopes located in over 200 towns. Such a vast industry opens up many opportunities for new jobs, greater incomes, and more hotel profits in many towns.

New England's newest major business continues to grow rapidly but geographic, economic and institutional factors will determine in which localities development is likely to be most rapid and capital investment safest. Geographic technique offers the best method for analyzing and synthesizing the complex forces that determine the growth and spread of ski centers.

Prior to 1910 interest in skiing was largely confined to groups of Scandinavians living in scattered snow centers in New England and the West. The Nansen Ski Club of Berlin, New Hampshire, is credited with being the first organized ski club in America. In 1910 the Dartmouth College Outing Club was founded and the first winter carnival was held in 1911. In 1913 Dartmouth and McGill inaugurated dual ski competitions. Not until 1926 was the first downhill race organized and run by the Dartmouth Outing Club. Jumping and cross-country running dominated the ski meets during this period. College skiers were the chief exponents of skiing until 1925 when the second institutional force in New England ski history, the Appalachian Mountain Club, began to run ski trips to its cabins and trails in the White Mountains. In later years the club built additional trails in southern New Hampshire and increased its facilities in Pinkham Notch. In 1931, the third major influence of the pre-ski-tow era, the Snow Train service of the Boston and Maine Railroad, increased the ski fever to a higher pitch.

The holding of the winter Olympics at Lake Placid in 1932 brought the attention of thousands to skiing at a time when the public was becoming aware of the fascination of downhill skiing so popular with the college boys. The invention of the ski tow at about this time, eliminating the tiresome and time-consuming climbing up the hills, gave great impetus to the growing interest in skiing. The ski tow, and later the tramways, permits more miles of downhill running per day and hence makes it easier for beginners to learn ski technique during the few week-ends available to the average skier, the great majority of whom must work during the week and confine their skiing to

FIGURE 1.—The regional grouping of ski centers is the best method for analyzing the conditions which have caused the concentration of New England ski facilities in particular localities. (Source: Location of ski centers based on "Skier's Guide to New England," New England Council, Boston, 1940–41. Regional boundaries drawn by author.)

Saturdays and Sundays. Thousands of people, who dared to run open slopes but not narrow, winding, wooded mountain trails, became new devotees of this ancient winter sport. The ski tow and the increased popularity of the open slope brought skiing out of the mountains and woods and spread ski centers over all New England. The number of ski centers in New Hampshire doubled from 37 in 1936–37 to 74 in 1940–41.

Any discussion of the locational factors operating in an industry as youthful as that of skiing must take into consideration the part played by individuals and institutions. Mention may be made of the many championship Dartmouth College ski teams; the less publicized but nevertheless active graduates of the college, who comprise a large part of the weekly ski competitors; the coach of the Dartmouth Ski Team from 1930 to 1936, Otto E. Schniebs, an important influence because of his enthusiasm and ability to instruct; the local ski clubs which built and maintained ski trails and slopes in many towns; the influx of Austrian and Swiss ski instructors and the founding of ski schools; the planning and construction of ski facilities by the National Forest Service and state planning bodies; the well-managed United States Eastern Amateur Ski Association; and the many private citizens who invested their savings in the construction of ski services and provided lodgings.

The combination of forces operative throughout the short history of modern skiing has resulted in more than two hundred towns being recognized as ski centers in New England. A ski center may have one or a combination of several ski facilities to offer the skier such as mountain trails, open slopes, jumps, and cross-country running. The ski centers are scattered from central Connecticut to northern Maine, from Lake Champlain to Boston, but, as is true of the majority of the region's industries, most of the ski centers are concentrated in 14 per cent of the organized towns of New England (11 per cent of the organized and unorganized towns) (Figure 1).

The analysis of conditions that determine where a ski center did, or will, develop involves sorting and grouping of a complex combination of factors as evidenced in the preceding historical treatment. At the same time consideration must be given to a wide variety of snow and slope conditions. Division of the ski towns into regions provides the simplest technique for describing and analyzing the factors that combine to determine why some regions possess more ski centers than others.

TABLE I

SNOW DEPTH AND SKI FACILITIES OF NEW ENGLAND BY REGIONS

Number	Name	Number of Weeks Snow Cover Averages 5" Plus[1]	Number of Ski Towns[2]	Per Cent All New Eng. Ski Towns	Per Cent Ski Towns of All Towns Within Each Region	Per Cent of Total Number of New Eng. Mountain Ski Trails[2]	Per Cent of Total Mountain Ski Trail Mileage[2]	Per Cent of Total New Eng. Ski Tows[2]
I.	Northern White Mountains	14–20	1	0.4	0.6	0.0	....	....
II.	Southern White Mountains	12–16	27	11.0	47.0	25.0	27.0	12.0
III.	Green Mountains	12–16	23	10.5	29.0	11.0	24.0	11.0
IV.	Lakes-Monadnock	10–14	33	15.0	38.0	16.0	15.0	19.0
V.	Upper Connecticut Valley	10–14	28	12.8	56.0	11.0	7.5	19.0
VI.	Connecticut Valley Uplands	10–14	7	3.1	8.0	3.0	.5	3.0
VII.	Uplands and Coastal Plain of Maine	8–14	12	5.5	2.0	7.1	3.9	3.8
VIII.	Berkshires	4–10	22	10.0	51.0	10.4	8.0	12.0
IX.	Western Vermont	4–10	4	1.8	7.4	0.2	0.8	0.6
X.	Lower Connecticut Valley	0–6	15	6.8	28.0	5.5	7.5	0.6
XI.	Southern New England	0–6	44	20.0	7.6	8.2	4.1	14.0

[1] Derived from data in: "The Distribution of the Average Depth of Snow on Ground in New York and New England," Robert G. Stone, pp. 672–692, Transactions, American Geophysical Union, 1940.
[2] Compiled from "The Skier's Guide of New England," Sixth Edition, 1941, New England Council.

There are eleven broad ski regions in New England. The boundaries of the regions as drawn on the map, Figure 1, coincide with topographic boundaries as in the case of the Green Mountain Region; or include towns whose ski interests are related to a central town from which ski fever and interested persons have moved to build ski facilities in neighboring towns, as in the Upper Connecticut Valley where the Dartmouth influence has spread into neighboring communities; or between areas of ski growth and non-growth as in the case of the boundary that separates the northern White Mountains from the southern White Mountains.

The degree of ski development in a given region and the rank of the different regions when they are compared to one another may be measured by the number and percentage of New England ski towns included within a region as well as by the number of mountain trails and their mileage, the number of ski tows, jumps and cross-country trails and the percentage of the New England total of each facility located in a given region. (Table I.) Capital invested, number of skiers per season, and dollars spent for lodgings, food, and gasoline are important measurements of the rank of a region but are unobtainable.

The eleven ski regions vary greatly in importance and popularity. The northern White Mountains are undeveloped, while the southern White Mountains include 11 per cent of the ski towns of New England. Forty-seven per cent of the towns within the region contain ski facilities. The region possesses 25 per cent of all New England ski trails, 27 per cent of the mountain ski trail mileage, and 12 per cent of the ski tows. Similar contrasts are found between other regions and suggest the classification of the ski regions into two broad groups. The dominant one contains the most developed regions and those likely to enjoy the greatest growth in the future. The least developed ones are placed in a minor group.

The dominant group of ski regions, with only 19 per cent of all towns in New England (organized and unorganized), includes 62.4 per cent of the ski towns, 70 per cent of the mountain ski trails, 74 per cent of the mountain ski trail mileage, and 74 per cent of the

ski tows. The regions included within the group are the southern White Mountains, Green Mountains, Lakes-Monadnock, Upper Connecticut Valley, and the Berkshires (Figure 1 and Table I).

The minor group of ski regions, with 81 per cent of all the towns in New England inclosed by its borders, possesses only 37.6 per cent of the ski towns, 30 per cent of the mountain ski trails, 26

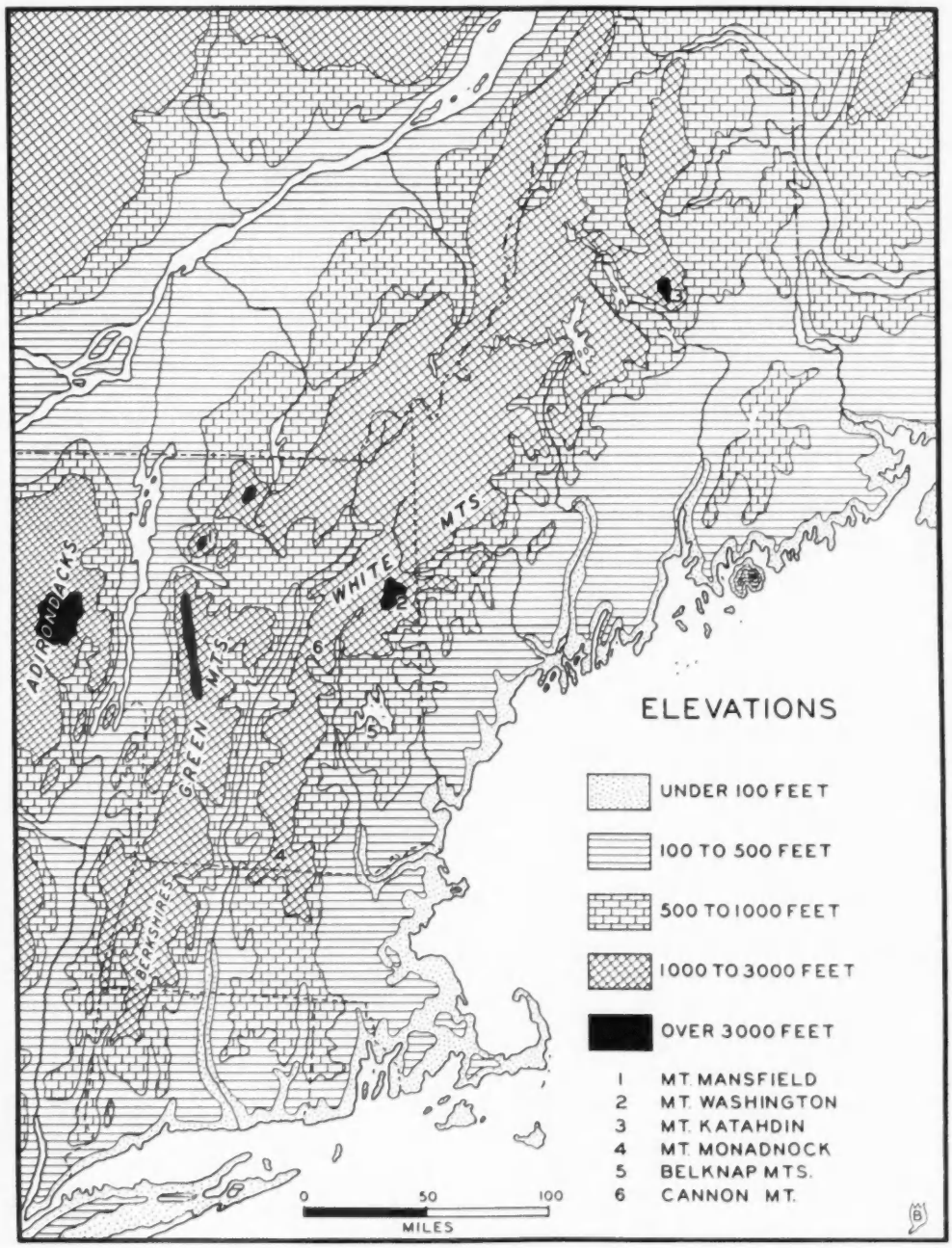

FIGURE 2.—Most of the ski centers in New England lie within the upland and mountain regions where elevations in general range above 1,000 feet.

per cent of the mountain ski trail mileage and 30 per cent of the ski tows. The minor group is dominated by the southern New England region in contrast to the dominant group where ski towns and equipment are more equally divided between the regions. Southern New England region contains 52 per cent of the ski towns within the group, 34 per cent of the mountain ski trails, 28 per cent of the mountain ski trail mileage, and 62 per cent of the ski tows. Ski regions of the minor group are the Connecticut Valley Uplands, western Vermont, Uplands and Coastal Plain of Maine, lower Connecticut Valley, and southern New England.

Terrain and winter climate, especially depth and duration of snow cover, are the basic factors to which every explanation of the distribution of ski centers and regions must be referred, although they are not the only ones as is shown by the fact that the region with the longest ski season is undeveloped (northern White Mountains), while the one with the shortest ski season is well-developed (southern New England). Other geographic and non-geographic factors will be described in each region after the description of slope and climatic conditions.

Skiers preferred mountain trails until six or seven years ago when the open slopes came into great demand. Hence, the early ski centers were found chiefly in or adjacent to mountains but, at present, a town may be classified as a ski center if it contains only open slopes. New England provides thousands of sites for both types of skiing, but the uplands and mountains possess the best ski terrain (Figure 2). In certain localities within the mountains are found slopes superior to the average slopes in the region as, for example, Mount Mansfield in the Green Mountains or Tuckerman Ravine in the

FIGURE 3.—The east slope of an esker makes a fine practice ski slope for beginners on the golf course in Hanover. (Courtesy of A. N. Bouchard.)

Presidential Range. In contrast to the attraction of the few superior sites are many hills satisfactory for skiing but not startlingly so. The latter type of terrain provides hundreds of New England towns with potential ski terrain and constantly acts as an encouragement for communities to build ski facilities. However, as we shall note later, many factors other than slopes must be present if a successful ski center is to be developed. The ski regions actually hindered by lack of numerous steep slopes, southern New England, lower Connecticut Valley, western Vermont lowlands, and coastal portion of Maine, nevertheless possess much rolling country which appeals to novices and will be used by persons unable to reach the more rugged sections of New England.

Snow for skiing! The phrase brings a variety of images to the mind of different skiers. To some it may mean a four- or five-inch fall of light, dry, powder-snow covering a two- or three-inch hard-packed frozen base on which they may describe sweeping, graceful telemarks; to others it may mean the granular "corn snow" of spring; some may remember the poor skiing on the deep, wet, sticky snow of March, 1940, when they drove a hundred miles with

the hope of finding low temperatures and fast skiing; for many ski tow enthusiasts it recalls hard-packed, icy snow permitting slippery dashes down some favored ski slope; to many persons it is a challenge to use their skill with ski wax. The wide choice of ski wax and the enthusiasm of the skier makes almost any snow cover suitable for skiing so long as it covers the ground. The only requisite is a few to several inches of base snow so that soil and rocks will not gouge the skis. All these types of snow exist in all the ski regions at one time or another during the winter. The only statement one can make with regard to the kind of snow in the different ski regions is that, after a suitable base has been established, light, fluffy snow is more frequent in midwinter at higher elevations and in the more northerly latitudes, the base snow more persistent, the average depth of snow cover on a given date greater, while granular snow develops in late winter and spring in all regions.

The winter climate in New England is characterized by temperature decrease and the increase of annual snowfall with increase in elevation and latitude. The length of the winter and the number of days with snowfall increase with elevation and latitude also (Figure 2 and Table II). Temperature and snowfall data, however, are not very satisfactory guides to the amount of snow available for skiing at a given date or for measuring the length of the ski season because of frequent thaws. Snow cover, the result of temperature and snowfall, is the best guide (Table III). Therefore, the popularity of a ski center, as well as the profit obtainable therefrom, assuming that satisfactory slope conditions exist, may be determined best by knowledge of the depth

FIGURE 4.—Mt. Moosilaukee, New Hampshire. Hell's Highway, one of the premier racing trails in the East, is marked by the open cut in the forest on the mountain slope in the center of the scene. (Courtesy of A. N. Bouchard.)

TABLE II

MONTHLY WINTER TEMPERATURES AND SNOWFALL[1]

Station and Elevation	*November*	*December*	*January*	*February*	*March*	*April*	*Yr.*
NORTHFIELD, VT. 876′							
Mean Maximum Temperature	41.1	29.2	25.8	26.0	36.2	50.2F°	
Mean Temperature	32.7	20.0	15.2	15.7	26.2	39.8	
Mean Minimum Temperature	24.3	10.8	4.7	5.4	16.2	29.3	
Average Depth Snow (Inches)	9.1	14.6	18.6	19.4	17.2	5.4	85.2
BETHLEHEM, N. H. 1,470′							
Mean Maximum Temperature	39.5	22.3	25.2	25.2	37.0	50.0F°	
Mean Temperature	31.8	16.4	15.4	15.2	27.2	40.0	
Mean Minimum Temperature	24.0	10.5	5.7	5.1	17.4	30.0	
Average Depth Snow (Inches)	10.9	13.2	16.5	18.8	12.4	7.4	81.1
N. BRIDGTON, ME. 450′							
Mean Maximum Temperature	44.6	33.1	29.4	30.8	41.8	53.5F°	
Mean Temperature	35.8	23.6	18.8	19.6	30.9	42.4	
Mean Minimum Temperature	27.0	14.2	8.3	8.4	20.0	31.4	
Average Depth Snow (Inches)	7.4	15.4	19.6	23.7	18.2	3.9	88.4
KEENE, N. H. 506′							
Mean Maximum Temperature	46.2	32.2	31.4	31.6	43.8	56.9F°	
Mean Temperature	35.9	22.9	21.0	20.0	32.3	44.0	
Mean Minimum Temperature	25.6	13.6	10.5	8.4	20.8	31.2	
Average Depth Snow (Inches)	4.3	11.4	14.7	16.5	12.1	3.0	62.0
FITCHBURG, MASS. 550′							
Mean Maximum Temperature	47.2	35.3	32.8	32.4	43.8	55.4F°	
Mean Temperature	38.7	27.6	24.5	23.4	34.4	45.4	
Mean Minimum Temperature	30.2	19.8	16.2	14.3	25.0	35.4	
Average Depth Snow (Inches)	3.5	11.8	13.9	16.9	11.0	2.6	59.7
BOSTON, MASS. 124′							
Mean Maximum Temperature	49.2	39.1	35.8	36.0	43.4	54.0F°	
Mean Temperature	41.9	31.9	27.9	27.8	35.7	46.0	
Mean Minimum Temperature	34.7	24.7	20.0	19.7	28.0	38.0	
Average Depth Snow (Inches)	1.7	8.3	11.7	12.2	8.0	2.6	44.5
HARTFORD, CONN. 159′							
Mean Maximum Temperature	49.2	37.7	35.3	33.9	44.9	56.6F°	
Mean Temperature	41.5	30.8	27.6	25.7	36.4	47.3	
Mean Minimum Temperature	33.8	23.9	20.0	17.4	27.9	38.1	
Average Depth Snow (Inches)	1.3	8.0	9.2	13.1	7.2	2.0	40.8
CREAM HILL, CONN. 1,300′							
Mean Maximum Temperature	45.2	33.2	31.0	30.2	41.8	52.3F°	
Mean Temperature	36.9	25.7	23.1	21.6	32.7	43.0	
Mean Minimum Temperature	28.6	18.2	15.2	13.1	23.6	33.8	
Average Depth Snow (Inches)	6.7	17.6	16.3	19.2	14.2	5.4	79.4

[1] Source: Sections 105 and 106, Summary of Climatological Data for the United States, Weather Bureau, U. S. Department of Agriculture.

of snow cover, its duration and trustworthiness. (References: Brooks, Charles F., "New England Snowfall," *Geographical Review*, American Geographical Society, pp. 222–240, 1917; Stone, R. G., "Snow for Skiing in New Hampshire," *The Ski Annual*, U. S. Eastern Amateur Ski Association, pp. 62–69, 1934; Stone, Robert G., "The Distribution of the Average Depth of Snow on Ground in New York and New England (II): Curves of Average Depth and Variability," *Transactions*, American Geophysical Union, pp. 672–692, 1940.)

Satisfactory skiing requires a base cover of three to five inches on most open slopes. Mountain trails require more snow, varying in amounts up to 15 inches. The number of weeks with an average depth of snow cover of five inches or more was chosen for comparing the length of ski season in the different regions (Table III). If eight or ten inches of average depth of snow

TABLE III

DURATION OF SKI SEASON AND AVERAGE DEPTH SNOW COVER IN INCHES AT GIVEN DATES[1]

Ski Region and Locality	*Altitude*	*Period of Record*	*Total Years*	*October*		*November*		*December*		*January*		*February*		*March*		*April*		*No. of Weeks Av. Depth Snow Cover 5"+*[2]
				15	*31*	*15*	*30*	*15*	*31*	*15*	*31*	*15*	*28–29*	*15*	*31*	*15*	*30*	
I. NORTHERN WHITE MTS.																		14–20
Pittsburgh, N. H.	1660[1]	1917–36	20	0.3	0.4	2.5	4.7	9.2	14.4	19.9	25.7	30.0	32.1	31.1	26.9	17.0	6.5	
W. Stewartston, N. H.	1050[1]	1930–36	7	0.0	0.0	1.0	1.0	2.7	6.8	9.1	21.1	21.1	26.2	21.6	15.8	7.8	0.5	
II. SOUTHERN WHITE MTS.																		12–16
Bethlehem, N. H.	1440[1]	1893–36	44	0.0	0.0	2.0	2.7	4.6	6.6	8.6	11.8	15.4	14.7	12.9	4.8	0.8	0.0	
Pinkham Notch, N. H.	2000[1]	1929–39	11	0.2	0.6	1.6	2.1	7.6	14.5	17.6	26.8	30.7	33.6	37.4	28.2	17.4	3.8	
III. GREEN MTS.																		12–16
Garfield, Vt.	1300[1]	1919–32*	9	0.0	0.0	1.3	4.8	5.7	16.1	12.9	19.7	21.2	26.0	35.5	17.3	12.1	0.0	
Somerset, Vt.	2080[1]	1913–36	24	0.0	0.0	0.8	2.4	5.2	8.6	14.8	20.0	26.4	25.9	24.9	17.6	10.8	3.2	
IV. LAKES-MONADNOCK																		10–14
Sanbornton, N. H.	830[1]	1893–03	11	0.0	0.0	0.0	1.8	5.5	8.0	10.9	14.9	19.7	17.4	14.3	8.9	1.0	0.0	
Peterboro, N. H.	744[1]	1892–02	11	0.0	0.0	0.8	3.0	6.2	4.6	4.4	12.3	18.0	16.0	7.6	3.6	0.3	0.0	
V. UPPER CONNECTICUT VALLEY																		10–14
Hanover, N. H.	603[1]	1893–36*	34	0.0	0.0	0.3	1.5	3.0	4.1	8.8	10.0	13.6	10.1	7.5	7.2	0.7	0.0	
Woodstock, Vt.	800[1]	1896–36	41	0.0	0.0	0.8	2.5	4.5	9.2	8.9	16.3	16.4	18.6	13.5	7.8	1.0	0.0	
VI. CONNECTICUT VALLEY UPLANDS																		10–14
Chelsea, Vt.	1070[1]	1901–36*	31	0.0	0.1	1.8	2.7	6.6	9.2	14.4	14.7	27.5	20.7	21.5	12.5	2.8	0.2	
Grafton, N. H.	863[1]	1893–17	25	0.0	0.0	1.4	1.4	4.9	6.4	9.9	12.4	18.2	16.9	11.3	4.1	0.4	0.0	
VII. UPLANDS AND COASTAL PLAIN OF MAINE																		8–14
Lewiston, Me.	182[1]	1906–36	31	0.0	0.0	0.8	1.3	3.8	6.2	9.3	13.3	17.8	15.7	6.8	1.4	0.1	T	
Bar Harbor, Me.	20[1]	1901–36*	27	0.0	0.0	0.1	0.7	2.1	2.6	5.2	8.2	12.1	11.1	7.8	1.9	0.3	0.1	
Houlton, Me.	364[1]	1902–36*	26	0.0	T	1.6	2.7	6.8	11.9	14.0	25.4	27.4	30.2	16.5	8.6	2.1	T	
VIII. BERKSHIRES																		4–10
Hoosac Tunnel, Mass.	800[1]	1931–36	6	0.0	0.0	0.7	0.8	2.6	1.8	5.3	12.6	18.4	18.0	11.1	7.2	0.3	0.0	
Stockbridge, Mass.	850[1]	1930–36	7	0.0	0.0	0.7	T	0.7	2.2	3.4	7.3	9.0	9.5	3.0	0.7	0.1	0.0	
IX. WESTERN VERMONT UPLANDS																		4–10
Enosburg Falls, Vt.	422	1904–36	33	0.0	T	0.8	1.3	3.4	5.2	6.1	8.0	9.2	8.3	5.4	1.5	0.1	0.0	
Wells, Vt.	900	1893–20	28	0.0	0.0	1.7	0.9	4.2	3.8	7.2	6.3	12.2	9.5	7.4	6.3	0.0	0.0	
X. LOWER CONNECTICUT VALLEY																		0–6
Turners Falls, Mass.	200[1]	1893–36*	44	0.0	0.0	0.2	0.7	2.4	3.0	5.4	7.0	10.4	7.4	2.8	1.2	T	T	
Holyoke, Mass.	90[1]	1905–36	12	0.0	0.0	0.4	T	2.2	2.1	2.6	6.8	10.6	9.2	2.6	0.4	0.0	0.0	
XI. SOUTHERN NEW ENGLAND		1901–05																0–6
Brookline, N. H.	250[1]	1910–18	14	0.0	0.0	0.1	1.0	5.0	4.2	8.4	8.2	14.4	10.8	8.1	0.5	0.3	0.0	
East Templeton, Mass.	1200[1]	1894–06	13	0.0	0.0	0.8	2.9	3.4	4.1	4.6	7.9	12.3	7.8	4.1	1.9	0.1	0.0	
Ludlow Center, Mass.	239	1893–06*	8	0.0	0.0	0.0	0.4	4.0	3.8	3.7	11.3	12.9	10.6	5.7	0.3	0.0	0.0	
New Bedford, Mass.	63[1]	1894–36*	20	0.0	0.0	0.0	0.8	0.7	0.5	1.1	2.2	3.5	2.3	0.9	0.4	0.2	0.0	

*Broken record with many gaps.

[1] Stone, Robert G., "The Distribution of the Average Depth of Snow on Ground in New York and New England," Transactions, American Geophysical Union, pp. 672–692, 1940.

[2] An average depth of snow cover of 5" was chosen as a suitable measure of the duration of the ski season and this column represents the approximate number of weeks with average depth of snow cover of 5" plus for each ski region as a whole.

cover is taken as a measurement of the duration of the ski season instead of five inches plus, communities at low elevations, valleys, and the southern portion of New England have a much shorter ski season, while the season in the upland and mountain regions is not a great deal shorter. Thus, the five-inch depth favors the regions with low elevations and least annual snowfall. However, in general, the ski regions maintain the rank given them by the five-inch

depth when eight- or ten-inch depth is used. The mountains and uplands with their deeper winter snow cover do not have so long a ski season as one might expect, because the rapid rise in temperature in spring quickly melts the deep snow cover (Table II).

The northern and southern White Mountain regions and the Green Mountains have a snow cover which is deeper and more persistent than the other regions (Table III). The Lakes-Monadnock, upper Connecticut Valley, and the Connecticut Valley uplands hold an intermediate rank between the northern mountains and the mountains and lowlands of the remainder of New England. The southern White Mountains possess two localities with ski conditions peculiar to them, namely, Tuckerman Ravine and Cannon Mountain. The latter, because of accessibility of higher slopes via the Cannon Mountain Aerial Tramway, affords earlier and later skiing than found in the remainder of the region except for Tuckerman Ravine where late spring skiing is excellent. Mount Mansfield has a longer season than other parts of the Green Mountains. The ski season on the higher portions of the western slopes of the Berkshires in Massachusetts may be somewhat longer than in the region as a whole.

Persons investing capital in ski facilities require knowledge of the reliability of the snow cover from year to year. Robert G. Stone ("The Distribution of the Average Depth of Snow on Ground in New York and New Eng-

FIGURE 5.—Hanover, marked by the white towers in the left center of the picture, and located on the east side of the Connecticut River, lies on an eroded lake plain that abuts on the higher slopes and mountains of the uplands. The rolling terrain of the lake plain and the open slopes on the adjacent hills (note the open spaces on the forested hills to the east of the town) are popular ski sites. Moose and Smart Mountains, east background, possess steep racing trails. (Courtesy of A. N. Bouchard.)

FIGURE 6.—The "Skimobile" which consists of individual steel cars with four pneumatic tires operated on a plank platform and powered by electricity and an endless steel cable, makes skiing pleasant in the eastern slope region by carrying skiers approximately 2,800 feet up the slope. (Courtesy of Eastern Slope Tram.)

land," *Transactions*, American Geophysical Union, pp. 689–692, 1940) has drawn expectancy diagrams for several New England stations which show "the per cent of years (at a given date) to expect more than a certain number of inches of snow on the ground." The graphs show that the chance for sufficient snow cover is greatest in February and March, less in December and January. The risk of poor snow cover in the uplands is slightly greater than in the mountains, while southern New England has the least reliable snow cover. In general, ski regions with the greatest number of weeks with an average snow cover over five inches have the most reliable snow cover from year to year (Table III).

Comparison of ski regions on the basis of number of weeks with snow cover averaging five inches plus in depth shows that snow conditions alone are not sufficient explanation for the dominance of one ski region over another, nor is suitable snow for skiing the only factor necessary of consideration in determining the possibilities for winter sports development. The northern White Mountains region with the longest ski season is undeveloped while the southern New England region with the shortest ski season includes many ski towns. Neither are the Connecticut Valley uplands nor the uplands of Maine so intensively developed as they should be on the basis of snow conditions and terrain. Since snow and slope conditions are only part of the explanation of the different development of the ski business from one portion of New England to another, the description of the rise of skiing in the upper Connecticut Valley and in the southern White Mountains provides a guide for the more complete understanding of the evolution of skiing in the other regions.

The upper Connecticut Valley region extends from St. Johnsbury on the north to the Massachusetts boundary line in the south and includes towns adjacent to the Connecticut River, except Woodstock, Vermont. Continuity is given this region by the valley locations of the towns, the growth of many of the ski centers because of their location near Dartmouth College and its ski fever, and by lack of ski centers in the adjacent uplands.

Early skiing at Dartmouth, in the period from 1910 to the early thirties, found the slopes of an esker and the eroded lake plain on which the college is situated ideal for learning ski technique, while Dartmouth Outing Club hiking trails were adequate for cross-country work (Figure 3). As ski skills increased, the carriage road on Mount Moosilaukee, some forty miles north of Hanover, attracted the better skiers and here downhill racing was born

(Figure 4). The terrain of Hanover and Woodstock was found to be ideal for open slope skiing (Figure 5). Later the ski fever reached a new peak when, in the early thirties, ski tows were installed first at Woodstock, Vermont, by Bunny Bertram, ex-Dartmouth skier, and then in Hanover by the Dartmouth Outing Club. Snow depths were satisfactory and the snow cover of long enough duration to encourage the students to invest in equipment and to provide a long enough season during which they could learn to ski.

To the active demand created by the Dartmouth men and the excellent geographic conditions must be added two other advantages of this region, namely, accessibility and ample accommodations. The ski communities are only four to five hours' ride from the chief center of demand, southern New England. Summer vacationists have frequented the towns in the region and lodgings originally built to accommodate them were available for the week-end skiers. Returning Dartmouth alumni, championship Dartmouth ski teams and the much publicized winter carnivals were added factors in the growth of this region as a winter sports center.

Brattleboro, in the southern portion of the region, has long been famous as a ski jump town, while local demand accounts for the ski facilities built in the northern portion of the region.

The southern White Mountains region, with such popular ski centers as Franconia and the eastern slopes district, serves to illustrate several other conditions that have contributed to the growth of the major ski centers. The region extends from Farmington, Maine, Berlin, New Hampshire, and Lydonville, Vermont, on the north to North Woodstock and Conway on the south. Berlin, the home of the Nansen Ski Club, had been a center for cross-country running and jumping for many years before the recent rise in the popularity of downhill skiing. It is still known primarily as a "jump" town. The present impetus to skiing on the eastern slopes of the White Mountains came after the National Forest Service built a fire trail into Tuckerman Ravine in 1931. Appalachian Club members, who were well-acquainted with the Presidential Range in summer because of their systems of trails and cabins located there, and Dartmouth students soon discovered the excellent skiing to be enjoyed in March and April in Tuckerman Ravine. The original popularity of the Pinkham Notch area increased when the State Development Commission sponsored additional trail construction in the district by the Civilian Conservation Corps. The southern White Mountains

FIGURE 7.—Cannon Mountain aerial tramway car on way to the summit where snow comes earlier and remains later than at lower elevations. The mile long trip is made in less than eight minutes. Mt. Lafayette may be seen in the background. (Photo by Trask.)

region is the premier ski region in New England. What are its advantages?

To the impetus of an early start in the eastern slopes region where public agencies constructed and maintained ski trails, a costly undertaking often too expensive for individual towns or winter sports clubs to handle, must be added an exceptional terrain for the building of mountain trails and open slopes. Reliable snow cover is established at a rather early date and remains as late as in competing regions on open slopes and on many of the trails, while April and May skiing in Tuckerman Ravine and the Gulf of Slides prolongs the ski season beyond that of other regions. All winter long the heavy and frequent snowfalls on the heights of the Presidential Range are blown into the cirque-like ravines by the prevailing westerly winds. Until March the snow is too soft, the cold too great, and storms too dangerous to permit skiing, but in April and May the danger of storms is over and the snow is packed and corny, making excellent skiing snow.

North Conway, in the heart of the eastern slopes region of the southern White Mountains, lies only 140 miles from Boston. The significance of this fact is enhanced when it is realized that the ski centers of this region, with their northerly location, low temperatures and reliable snow cover are no farther from the center of New England demand than more southerly situated ski centers such as those in the Berkshires and in the upper Connecticut Valley. If you are a skier living in Boston and have your choice of ski regions you will go north where the chances of finding low temperatures and sufficient snow cover is greatest.

FIGURE 8.—Air photo of Cannon Mountain in Franconia Notch, New Hampshire, showing America's first aerial passenger tram line at extreme left, and system of down-mountain ski trails. The trails, left to right, are the Cannon Mountain Trail (intermediate), Tram Ravine Trail (intermediate to novice), and Richard Taft Trail (expert). Each trail is approximately two miles in length with a vertical drop of over 2,000 feet. The entire project is controlled by the state of New Hampshire through the New Hampshire Aerial Tramway Commission. (Photo by Trask.)

Glen, Jackson, Bartlett, North Conway, and Pinkham Notch are familiar names to summer vacationists who visit New Hampshire. These towns have entertained thousands of summer guests in their hotels, lodging houses, and cabins. Hence, as the ski craze grew, overnight accommodations were found plentiful. Lack of overnight accommodations, or their location at inconvenient distances from the ski trails and slopes, has, and will, retard the popularity of many otherwise excellent ski centers. Not only were lodgings available in the southern White Mountains region, but owners immediately saw an opportunity to spread their costs over a twelve-month period instead of a six-month period. Therefore, we find large funds spent to advertise the region and large capital outlays for new slopes and tows. The largest capital investment is represented by the Eastern Slope Inn, the Eastern Slope Ski School, and the Mount Cranmore development.

On the western side of the southern White Mountains, from Bethlehem and Franconia on the north through Franconia Notch to Lincoln and Waterville Valley on the south, lies the second most developed ski district, the Franconia District. This locality has been a

popular ski center for a number of years because of the activity of ski clubs and hotels that provided ski instruction and held championship races on steep, fast, sporty trails while contestants and spectators found excellent cuisine and rooms in famous summer vacation centers (Figure 8). New Yorkers have long found this region relatively accessible, while it is approximately the same distance from Boston as the eastern slopes region.

In the last few years the former conditions have been eclipsed to a great extent by construction by the State of New Hampshire of the Cannon Mountain Aerial Passenger Tramway. The tramway carries passengers nearly to the top of Cannon Mountain from which trails and open slopes radiate at elevations of 2,000 to 4,000 feet, insuring some skiing from late November into April (Figure 7).

The northern slopes of the southern White Mountains region, mainly because they are some 15 to 40 miles farther from the centers of demand, have experienced less growth in popularity than the southern districts.

The upper Connecticut Valley and the southern White Mountains regions provide examples of most of the forces operative in determining the growth of ski regions in New England. To what extent are those forces and conditions active in the other ski regions?

Among the dominant ski regions, in addition to the upper Connecticut Valley and the southern White Mountains, are the Green Mountains, Lakes-Monadnock, and the Berkshires. Construction of ski centers in the latter is largely a result of the steeper slopes and longer duration of snow cover there than in the surrounding uplands and lowlands, its nearness to metropolitan New York and New Jersey, plus the ability of ski clubs and other interested groups to secure expenditure of public funds for construction and maintenance of trails in the many state forests in western Massachusetts. Fifty-four per cent of the ski towns in Massachusetts are in or adjacent to public lands. A major handicap of the region, when compared to more northerly areas, is the shorter season with sufficient snow cover and the uncertainty of its depth and character.

FIGURE 9.—Two members of the Cannon Mountain Tramway Ski Patrol look back toward the Mountain Station and the trail development at the summit, at an elevation of approximately 4,000 feet. (Photo by Trask.)

The Green Mountain development has been largely on private lands and with private funds in contrast to the situation in the southern White Mountains and the Berkshires. The Stowe–Mount Mansfield sector is especially noteworthy in this respect. Snow and slope conditions are of the best, but further growth is hindered either by insufficient accommodations or by the greater distance of the northern section from metropolitan Boston when compared with most of New Hampshire.

The Lakes-Monadnock region, easily accessible to week-end skiers, dotted with hotels and lodging houses frequented by summer vacationists, and well-supplied with mountain slopes and an excellent midwinter snow cover of

fair reliability, shows even greater promise for an already extensively developed business.

In the minor group of ski regions the factors creating growth and development of ski facilities in the dominant group are lacking in whole or in part. The northern White Mountains region, with excellent slope and snow conditions, suffers because of its location far from the demand, from its lack of lodgings, and from its lack of local groups fostering skiing. The Connecticut Valley uplands present similar conditions, except for a location nearer the demand. Lack of lodgings and inaccessibility to the demand, in addition to less attractive ski terrain and a slightly shorter ski season, handicap growth in Maine. Most of its ski centers are responses to local demand. Similar conditions exist in western Vermont.

In the lower Connecticut Valley winter sports centers are a response to local demand for ski services in the middle of the winter on local mountains and on public lands. The southern New England region, with unreliable snow conditions, a short ski season, and few mountains, serves a large local demand satisfied by interested ski clubs and municipalities which operate ski centers with short trails and gentle slopes.

Growth of the ski business, irregular distribution of ski centers, and degree to which ski regions differ in development are not a result of slope and snow conditions alone. To the basic geographic factors must be added locally-interested groups with enthusiasm and capital, a location accessible to week-end skiers, lodgings to care for patrons, open winter roads and train service, public funds for trail construction and maintenance, ski instructors and schools, the desire of the summer vacationist to return to his summer haunts in winter, and miscellaneous historical conditions.

BOOK REVIEWS

KERNER, ROBERT J. *The Urge to the Sea; The Course of Russian History.* Published by University of California Press, Berkeley and Los Angeles, 1942. $2.50.

The role of Russia in the present cataclysmic war intrigues the imagination and interest of the whole world. The United Nations have been astonished by the unexpected military strength of the Soviet armies. They have marveled at the tenacity with which the Russians have held their positions and maintained their morale against overwhelming odds in attack after attack of the highly disciplined and effective forces of the totalitarian Germans and their allies. The Russian will to defend every square mile of Russian homeland has excited the admiration of friend and foe. Today the world is even more eager to learn of Russia than it has ever been before, though Russia has for centuries been an important factor in the course of world history.

This recent book from the pen of Robert J. Kerner, Sather Professor of History in the University of California, and the printshop of the University of California Press attempts to summarize the role of rivers, portages, ostrogs, monasteries, and furs in the development of the powerful Russian state from the inchoate mass of peoples and cultures that occupy its territory. As far as he goes the author achieves his purpose successfully, and makes a major contribution to the literature from which an appreciation and understanding of Russia's place in the economy and politics of the world, and the operations of this world war may be gained.

An historian, Professor Kerner revives the interpretative technique and basic anthropogeographic principles which dominated the practice and philosophy of geography in America thirty years ago and in Germany for the thirty decades earlier as well. He writes from the point of view and with the convincing pen of Rätzel and Ellen Churchill Semple. Their voices may again be heard in the persuasive arguments and synthetic conclusions that Professor Kerner uses so effectively. Though most geographers no longer look at the world and its phenomena with integrating eyes, preferring to devote themselves to the minutiae of lesser regions, anthropologists, historians, economists, and sociologists increasingly turn to sound geographic disciplines for integrating the relationships between man and his attributes and activities as one major element and place (or land) and its characteristics as the other in the great complex of the science of man.

The better and more authoritatively to state Professor Kerner's point of view and position, quotation of some length from his preface is only fair and desirable, as follows: "For historians, and in fact for most social scientists, the expansion of Russia and the building by the Russian people of a vast Eurasian empire is a story of major importance. What forces, geographic or economic, political or social, material or spiritual, became active in that urge to the sea which was a prime factor of Russian expansion into three continents? Through what instruments and in what ways did these forces act? And what do they imply for the future as their activity gains direction? These and many other questions are raised, if we view this problem in the long perspective. Adequate answers would give fuller meaning not only to the entire sweep of Russian history, but possibly also to the history of Europe and Asia. In this monograph the role of rivers, portages, ostrogs, monasteries, and furs is analyzed with a view to indicating their respective parts in this absorbing story. Here geography and history, economics and politics, religion and social life were but components, or adjuncts, of one powerful force which carried a people from the innermost sources of great rivers to the majestic seas into which they flow.

"My interest in this subject was first aroused seven years ago by work on a monographic and documentary history of Russian eastward expansion. The role of the factors enumerated above indicated that they constituted the driving power and the mechanics of the expansion. A study of these factors in Russian history from early times indicated that they were at work in the whole course of Russia's historical development and in all directions to the seas. A preliminary statement was given to the press on February 10, 1937 (see *New York Times*, February 23, 1937).

"I have no desire to emphasize any deterministic interpretation, nor to lay claim to the complete working out of this set of factors in every detail of every epoch and region of Russian history. That would represent the task of a lifetime. All that I have endeavored to do has been to indicate the chief factors at work, the main direction and character of their action, and the results of their activity. The rest I must leave to other scholars as they work through the history of the Russian people and have an opportunity through detailed research to confirm or to reject the indicated influence of rivers, portages, ostrogs, monasteries, and furs on the course of Russian history."

Professor Kerner lists a large number of references in his footnotes. Among those references three are of particular significance. The first is by Z. Khodakovskii, who first thoroughly studied the means of communication in ancient Russia. The second is by Sergei Mikhailovich Solov'ev, who first clearly pointed out the significance of the factors that effected the imperial expansion of Russia across the Urasian continent. The third is by the distinguished Russian historian, V. O. Kliuchevskii, whose main thesis is that "the history of Russia is the history of a country in the process of colonization" in which primitive and natural means of movement are significantly effective in the character and extent of the movement.

Professor Kerner begins his thesis with the Valdai Hills region, the hydrographic center from which the radial expansion of the Russian

state spread in all directions, follows up with a discussion of the Kievan state which formed the corridor for the passage of the Baltic Varangians to the Euxine and the Greek culture, and then in sequence the rise of Novgorod and Moscow as centers of Russian development. The most of the book is devoted to the expansion of Russian sovereignty by means of the natural highways eastward, southward, and westward.

It is a fascinating book.

W. E. E.

FREEMAN, OTIS W., AND MARTIN, HOWARD H., Editorial Committee. *The Pacific Northwest: A Regional, Human, and Economic Survey of Resources and Development.* Published by John Wiley & Sons, Inc., New York, 1942.

In this first geographical and regional survey of the Pacific Northwest the authors have given us a study comparable with the many authoritative and comprehensive summaries of New England, the South, and other special regions of our country. Such a survey is always ambitious and requires a great deal of discrimination and care in the choice and presentation of materials, if it is to have the value and significance for the reading public expected of it. The authors have achieved remarkable success in their presentation of their material; it is likely that this volume will stand as the primary source work for the Pacific Northwest region for many years to come. It is authoritative and inclusive; it is discriminating and well balanced in its choice of material; it is written well, it is easy to read, and the mechanical make-up of the book is superior. Unquestionably it will remain for many years the outstanding authority on the region, as it deserves to be.

The book is divided into six major divisions. Part I. concerns itself with changing human adjustments, and includes Indian life of the region and the White Man's exploration, political adjustments, and settlement. Part II. in orthodox geographic sequence treats the physical environment. Part III. deals with the exploitation and conservation of natural resources, and fundamental phases of land utilization. Part IV. is devoted entirely to the agricultural geography of the section. Part V. takes up in detail the industry and commerce that have accrued as a result of the exploitation and development of the regional resources. Part VI. summarizes the density and distribution of population, and the location and function of the cities and urban centers. In every way the book is a well-rounded example of regional treatment.

Thirty-one authors have contributed to the writing of the book, under the supervision of an editorial committee of three. An interesting foreword by John B. Appleton, Acting Director of the Northwestern Regional Council, and a brief preface by the editorial committee, Otis W. Freeman and Howard H. Martin, open the book. Important references on the text are appended to each chapter. A complete index closes the book. The book is well but not lavishly illustrated and the illustrations, both line cuts and half tones, have been excellently reproduced. A hard calendered paper and an open font of type make the text easy to read. In summary, it is an excellent book, and a complete and authoritative interpretation of the geography of one of the most fascinating regions of America.

W. E. E.

WICKIZER, V. D., AND BENNETT, M. K. *The Rice Economy of Monsoon Asia.* Published by Food Research Institute, Stanford University, California, 1941.

The Rice Economy of Monsoon Asia is one of those monographic works that marks a period in the field of any subject. It forms one of the precious volumes that after its publication is always considered a "source." Its exhaustiveness and accuracy indicate how carefully the material from which it is shaped has been assembled, and how judiciously it has been evaluated and selected for publication.

Rice economy is a huge subject and could have been made to occupy many more pages than this book includes, and Monsoon Asia is a great area which would justify a much longer treatment than is embraced within this study. Yet so carefully has the material for the book been chosen, and so artfully compacted, that it is not lacking in adequate treatment of the topic itself, nor of the region considered; both are presented in a detailed, uniform way and integrated into a thesis that holds attention from beginning to end.

The inclusiveness of the book can best be summarized by enumeration of the chapters into which it is divided. After a brief introduction, the environment of the world rice economy is condensed into one admirable chapter, which is followed by a more specialized treatment of the general features of lowland rice culture. Next the marketing and milling of the crop and the exports and import markets are treated. These two chapters are followed in turn by rice in Asiatic diets, price factors, changes and relationships, and government intervention and price control schemes. Two chapters on consumption trends follow, and these in turn are followed by two chapters on potentiality for rice expansion, one of them being devoted to yields and the other to acreage. The final chapter explains trends in Asiatic rice economy. Twenty pages of appended tables, fifteen pages of statistical notes, and a brief index conclude the volume. The mechanical make-up of the book is good, the style of writing is as facile as exposition can ever become, and the content of the volume is monographic. It is a fine book.

W. E. E.

JAMES, PRESTON E. *Latin America.* The Odyssey Press, New York, 1942. $4.50.

In his new contribution to the literature of South and Middle America for the general reader, Professor James has also given to the educational field a new and superior textbook for use in courses in the regional or economic geography of Latin America. Essentially geographic in its point of view and content, the book includes a

great deal of material not essentially geographic, which clarifies some of the complicated problems in the lives and activities of the Latin American peoples, and enhances the value of the work for historians and economists and statesmen, just as it broadens the knowledge of the college student and supports the geographic basis upon which the thesis of the book is built; that is, as the author states, "the relation between population distribution and density and such factors as the character of the land, political areas, racial patterns, and opportunities for economic development."

Professor James has adhered faithfully to the geographic discipline, the application of place, or locale, to his factual material, as the criterion by which to evaluate, classify, and organize the vast body of knowledge of Latin America which he presents within the covers of this book; and consequently he achieves an integrity of content and treatment that adds substantially to the significance and value of the book, both as a college text and as a popular reference. His long experience in active teaching of geography in the University of Michigan, his personal acquaintance with much of Latin America and many Latin Americans gained by years of travel, his keen appreciation of the conditions which affect the history of the Latin American nations, and his warm sympathy for their problems, as well as his concern that the United States and the Latin American nations should be good neighbors, eminently qualify him to write such an authoritative and able work as this.

Occasionally the author's pardonable enthusiasm breaks down his restraint and appears to lay his position open to criticism—for example the paradise he makes of Paraguay, admitting as he does its lack of minerals, might by comparison make Ohio and Pennsylvania seem seventh heavens, for they have coal to keep their angels warm when chill winds blow and drear skies darken the days. The reviewer has little desire (as perhaps he has little hope), despite Professor James's glowing description of the charms of Paraguay, of going there when he passes away.

The book is very satisfactory in its organization both for college courses, and for popular reading and reference. Four exhaustive parts follow the general introduction: Part I. Spanish South America; Part II. Portuguese South America; Part III. Mexico and Central America; and Part IV. The West Indies, British Honduras, and the Guianas; all integrated in a general conclusion. Excellent maps of much significance and in great profusion; a number of valuable appendices; a carefully and critically selected reference list, and a detailed index complete the body of the book. The text is very well written, for Professor James possesses a facile, fluent style that makes his weightiest material easy to read and understand, and a sense of humor as well as of fitness and propriety that lend charm and dignity to all that he writes. The book is long, more than 900 pages—textbooks seem to grow longer and longer, more and more ponderous, as the years go by—but it is inclusive of material and exhaustive in treatment.

One trenchant paragraph from the preface implies why such a book as Professor James's *Latin America* should be written, the need of better understanding between the nations and peoples of the Americas: "In many respects, to be sure, Latin Americans are remarkably similar to Anglo-Americans. It may be that the reader of this book will find too much emphasis placed on the differences which distinguish one group from another. After all, there are certain fundamental similarities which link together all members of the human race. Human beings of whatever color or nationality are actually moved by much the same fundamental forces, and the societies they build have a great many elements in common. There is always the same overwhelming triviality of daily living; there are always the moments of unselfish idealism which illuminate the drab monotony of human existence. Perhaps if we stressed these similarities more and the differences less, there would be less room for fear, and for that terrible result of fear—hatred. We must recognize that among the peoples of the Americas there are many common experiences and many common aspirations which can serve as a basis for the development of friendships and of mutual confidence and respect."

W. E. E.

HANNA, PAUL R., QUILLEN, JAMES I., AND POTTER, GLADYS L. *Ten Communities.* Published by Scott, Foresman and Company, 1940. $1.16.

Though an elementary textbook, *Ten Communities* deserves mention because of its case treatment of ten distinct geographic entities in our American commonwealth. The ten communities are Williamsburg, Virginia; New London, Connecticut; Atlanta, Georgia; Brazoria, Texas; Waterloo, Iowa; San Francisco, California; Seattle, Washington; Greeley, Colorado; Gary, Indiana; and New York City.

It represents an extension of college technique down into the secondary schools. Whether or not such a step is warranted is a question that the educator can better answer than the sociologist or the geographer. There has been just such an extension downward from the college into the secondary schools of the biological and physical sciences, and whether it has resulted in educational good or not is doubtful. Many high school students are skilled in the dissection of a cray fish or earthworm, but do not know a tanager from a barn swallow, a moccasin-flower from a fringed gentian; they speak glibly of chromosomes and Mendelian ratios, but have little idea of where the redbud grows or the mayflower blooms, cannot distinguish between an oak and a maple, and would not recognize the song of the wood thrush or the rollicking call of the flicker if they were to hear it.

And so it might be that though they could give in detail the characteristics of Brazoria, Texas, or Gary, Indiana, they might not be able to point out on a map of the United States where either Texas or Indiana are located. Students have come through the high schools that could not name half the states of the Union in their right place on a map, that have located Egypt in Monsoon Asia and Burma in South Africa,

that have not known where Rome, or Singapore, or Buenos Aires is.

Perhaps for the purpose that it is written, *Ten Communities* is fully justified; perhaps the educators are right in carrying the college approach to science down into the secondary schools; but there is increasing evidence that the students who come to college are lacking in certain fundamental knowledge that they ought to have if they are to go on into analytical research.

W. E. E.

BARUCH, BERNARD M. *American Industry in the War*. Published by Prentice-Hall, Inc., New York, 1941. $5.00.

Next to the armed forces of our country, industry and agriculture rank in importance for defense. The mobilization of the two great industries, agriculture and production on the one hand, and manufacture and distribution on the other requires as careful and elaborate system for totalitarian war as does preparation, arming, and deployment of all our armed forces. Modern industry is so complicated and so extensive that to be organized and integrated into one totalitarian force for an all out war, it must be systematized and unified in one great master-plan that takes into account every enterprise, every means of transport, every source of power and labor and raw materials, and finally, the direction of the ablest minds in the country, experienced in the technique of business. It is perhaps not going too far to say that World War I was won by American industry implemented almost exclusively for war production. The crushing weight of American munitions and equipment, once it was thrown into the balance of the war, was too great for the axis nations to compensate, and the scales were turned against them, ruthlessly.

Profiting by the lesson of the first World War, Germany and its allies have mobilized their industry and transport and labor in the hope of anticipating any effort that the United Nations might make, and in the belief that by striking first before the United Nations could bring their superior resources and industry to bear on the struggle they might win an early victory. With every month's delay their hope and their belief are weakened, and if the United Nations can survive this present summer and on into the early winter, the final outcome of the war is inevitable. Victory will certainly crown the tremendous efforts the United Nations are making to stem off defeat until they can have mustered their strength and their strategic superiority for the final merciless campaign that must bring the axis to its knees.

In the first World War the great mobilization of industry which was accomplished, it is fair to say, was accomplished largely by the superlative efficiency and ability of one man, Bernard M. Baruch, who occupied the first position in that mobilization. His account of the problems that had to be solved, and the way in which they were solved at that time, serves as an excellent guide for planning the industrial mobilization of this war. It is reported that Bernard M. Baruch has placed himself at the disposal of the government for the service of any bureau or division or agency of the government that needs his help, and that his sage counsel in more ways than one has directed industry into the channels of greatest usefulness, expedition, and efficiency. This book cannot be ignored in any plan for the speeding up of production or in the solution of any problem that confronts our great manufacturing and transportation organizations. It appeared on the scene at just the critical time and it is safe to say that it will endure as a guide throughout the period of the war.

The book is divided into two important sections: A relatively brief outline of the purposes, program, and achievements of the War Industries Board of the first World War; and a lengthy, exhaustive discussion of all the commodities that entered into the prosecution of the war and into the achievement of victory, including the metals, chemicals, refractories and abrasives, medical supplies, forestry products, textiles, leather and rubber goods, machinery and tools, and finally transportation and power. It is essentially a complete report for the American nation of the War Industries Board of that great war. Bernard M. Baruch writes his own foreword, and the late Hugh S. Johnson writes the introduction. The book is edited by Richard H. Hippelheuser. It runs to 500 pages of intrinsically valuable and interesting material. It constitutes a guide for the mobilization of industrialism for the military purposes of this war, and though it is not easy to read, it will repay every good citizen to study it in detail.

W. E. E.